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NAVAL SHIP UTILITY:
THE
SOVIET PERSPECTIVE

by

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This thesis critically reviews twenty-two articles from the Soviet Naval Digest, Morskoy Sbornik, dealing with a wide spectrum of measures of effectiveness such as individual time efficiency, ASW search effectiveness, command decision efficiency, effectiveness os ASW training, measures of force control, and others. These Soviet measures of effectiveness are categorized by level of combat action. Although there is some question about the specific Soviet meaning of the translations, this thesis uses the translator's rendering of the basic units of Soviet Naval organization: individual, sub-unit (podrazdeleniye), unit (chast'), and force (soyedinen-iye). The levels of combat action above force (generally agreed to be named front (front) and TVD (Teatr Voyennykh Deystviy) are not included in this study. The articles illustrate the Soviet tendency to organize their oper-ations research along the same lines as the units of naval organization

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Naval Ship Utility:
the
Soviet Perspective

by

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ABSTRACT

This thesis critically reviews twenty-two articles from the Soviet Naval Digest, *Morskoy Sbornik*, dealing with a wide spectrum of measures of effectiveness such as individual time efficiency, ASW search effectiveness, command decision efficiency, effectiveness of ASW training, measures of force control, and others. These Soviet measures of effectiveness are categorized by level of combat action. Although there is some question about the specific Soviet meaning of the translations, this thesis uses the translators's rendering of the basic units of Soviet Naval organization; individual, sub-unit (*podrazdeleniye*), unit (*chast'*), and force (*soyedineniye*). The levels of combat action above force (generally agreed to be named front (*front*), and TVD (*Teatr Voyennykh Deystviy*), are not included in this study. The articles illustrate the Soviet tendency to organize their operations research along the same lines as the units of naval organization and indicate that the most basic measure of naval ship utility is combat effectiveness.

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I. INTRODUCTION AND METHOD

)UND

:ant by Naval ship utility ? Why is it important ? Why would Soviet
y be any different from American or anybody else's ideas? If you
: ship, *Sovremmny* class, say, with an American *Spruance* class, which
letter for what purpose ? Which ship would you prefer to have in a
ng to Africa or Central America or the Middle East ? How would you
idron of ships so that it would be maximally effective in all combat
se are all questions of utility.

utility, then, is important because it is the central element framing
d strategy. Each side's measure of their relative strength determines
it, who they will fight, and when they will fight.

le, the *Styx* surface to surface missile enabled two Egyptian *OSA*
ink the Israeli destroyer *Elath* in the 1967 war before the destroyer
gun range of the patrol boats. But the same *OSA* tactics failed in the
i War against shorter range *Gabriel* missiles on Israeli *Sa'ar* patrol
ind Syrian *OSA* losses were so severe that the *OSA's* retreated to port
of the war. As Bathurst(1981) points out, the Israeli victory over a
orce (in number and range of missiles) can be explained by Israeli
counted for two things: the *Styx's* ten mile range advantage over
Arab's habit of firing their missiles at maximum range, significantly
ectiveness of their ship-borne missile guidance radars. The Israelis
ountermeasures and last-second maneuvers to defeat the missiles. In
ie enemy's utility was known well in comparison with their force. The
is fixed in advance.

Navy's case, the perfectly planned scenario doesn't exist. This means
are much harder to estimate for any given tactic. Even though there
y models in use derived from surveys like Multi-Attribute Utility
them because of their American origins.

of this thesis is to evaluate the Soviet perspective on Naval ship
Soviet idea of utility is probably different from the American's, given

the cultural, linguistic, and secrecy barriers separating the Soviet Union from the United States, it's important to use their measures. But using their measures of effectiveness has its advantages and disadvantages.

An advantage of using Soviet utility constructs will be in the precise terminology they will use since all analysis in the Soviet Union is framed by dialectical materialism (that's the Communist Party line and if one wants to be published, he follows the party line). If opposing viewpoints arise, as they are wont to do when American authors offer new ideas, the Soviet writers look instead for the "unity of opposites" to emerge. Since the Communist Party says that dialectical materialism provides the scientific basis for revealing the natural laws of the material world, once those laws are revealed , they can be applied to control natural phenomena, social processes, even political processes.

The Soviets have established Military Science as the theoretical branch of military affairs while the practical side is known as Military Art. The study of Military Science is 'science' to the Soviet. Science requires precise, unambiguous terminology. Military Science, therefore, will use precise, unambiguous terminology. Sources for understanding their meaning are *The Soviet Military Encyclopedia*, Soviet Military Science professors and writers, American and European Soviet military analysts, and official U.S. Government publications and translations. In this sense then, it is easy to get the Soviet perspective on Naval ship utility since the Soviet writers mean what they say when it's about Military Science.

The major disadvantage to using Soviet measures of effectiveness is the extreme difficulty of getting the complete General Staff model of naval ship utility, that kind of information is a state secret. Calculations regarding the effectiveness of an American electronic countermeasure against a Soviet SS-N-12 surface to surface missile, for example, will simply be unavailable.

If we can't get the complete picture, we can try the "jigsaw puzzle" approach, fitting pieces together, assuming that the pieces we see all fit the same puzzle. Eventually, there are enough pieces in place to deduce the rest of the puzzle. Many other more experienced analysts continue to work the puzzle. This thesis simply adds to the collection of pieces.

B. METHOD

The method for analyzing Soviet Naval ship utility is content analysis of Soviet open source writings on the subject which appear in the Naval Digest of the Main

Political Administration of the Army and the Navy *Morskoy Sbornik*. The Naval Intelligence Support Center translated all of the articles in this study.

The assumptions in this methodology are:

- Translations are reasonably accurate renditions of the original Russian.
- The highly specific contextual meanings of Soviet military thought have been preserved in the translations. (e.g., phrases like *upravleniye silami* have been consistently translated in the naval context as either "force control" or "command and control.")
- *Morskoy Sbornik* represents, for the most part, information for Soviet naval officers rather than disinformation for U.S. intelligence. And that any disinformation will be limited to political-military topics and not the science and technology aspects of ship employment.
- Soviet Naval Science is hierarchically structured and this structure will be imposed on the treatment of Soviet ship utility. The structure is defined by systems theory and cybernetic control.

C. SAMPLING

The samples from *Morskoy Sbornik* are later than 1973, because those before 1973 are all on microfilm and were too difficult to work with. I chose articles by scanning each *Morskoy Sbornik* annual index and picking those topics having some relevance to how ships, aircraft, or submarines are considered in terms of their effectiveness. The measures of effectiveness could be for individual, sub-unit, unit, or force levels of organization in the Soviet Navy. I initially selected thirty-four articles. After a more careful reading, I rejected eight because their subjects were primarily propaganda rather than operations research, engineering, psychology, or military science. Four more articles on the debate over the theory of the navy were rejected because the topic was more doctrinal[1] than analytical.

The different chapters reflect the levels of organization of the Soviet Navy as they emerge in translation; individual, sub-unit, unit, and force. The precise meanings of the Naval terms are not as well known as those of the Ground Forces, however, and the organization of this work into individual, sub-unit, unit, and force levels assumes there is some correspondence between Soviet Naval and Ground organizations since both spring from the same Soviet Military Science (and Party doctrine). The concepts are not clear and more work should be done to understand the Soviet structure of Naval forces. That is a task of immediate importance but beyond the scope of this thesis. The second chapter contains articles on the individual level, the third has

---

[1]In the Soviet sense of that word where doctrine is the Party's determination of how the next war will be fought, who the enemy will be, and what the objective of the war will be.

discussions which reflect the sub-unit (department in U.S.N. terms) level, the fourth and longest chapter covers the unit (ship/plane/sub/ as a whole tactical unit) level, while the last chapter deals with the force level (multiple-unit combinations). Again, each of the articles presents some measure of effectiveness to the Soviet naval audience. The order of topics in each chapter does not reflect the relative importance of one measure over another.

Understanding what is important to the Soviet naval officer in terms of how they conceptualize their own naval issues, what they worry about in deciding whether something is effective or not, or how they would analyze a tactical problem adds an extra dimension to the U.S. Navy's analysis of Soviet naval strategy.

D. SYNOPSIS OF THE SAMPLE ARTICLES

See Table 1 for a list of the subjects covered in each chapter.

The structrue for this thesis stems from Abchuk (1972, p.32). He classifies combat measures of effectiveness in several ways, one is based on a hierarchy of combat action. This category characterizes effectiveness by "the scale and nature of the investigated operation". Effectiveness criteria are divided by "scale and nature" as listed below:

- Strategic-characterizing military operations on a strategic scale.
- Operational-characterizing the success of military or naval operations.
- Tactical-characterizing the success of combat goals.
- Fire-characterizing the effectivness of a weapon's fire or the results of firing.
- Operational and combat probabilities characterizing combat operations, radioelectroninc warfare and the utilization of radioelectronic counter action media.
- Military-economic- characterizing the effectiveness of the military rear, industry, transportation, economic, and "other missions on this level".

The terms individual, sub-unit, unit, and force correspond to Abchuk's effectiveness levels fire, tactical, operational, and strategic.

TABLE 1

SUMMARY OF SUBJECTS COVERED IN THE SAMPLE.

Level	MOE Category	Subjects	Articles
Individual	Work Efficiency	Monitoring & Feedback of Naval Officer Work Habits.	1
	Man-machine Control Process Efficiency	Learning rates for Sonar, Radar Navigation Specialists.	1
Sub-unit or Department	Evaluate Discipline	Character. Group behavior. Frequency of Punishment.	1
	Optimum Spare Parts Mix	Choosing the best mix of spares constrained by weight	1
	Judging ASW team training	Speed and accuracy of decision support for C.O..	2
Unit-ship plane sub	Tactical Technical Elements	Engineering influences on combat effectiveness: Plant operation, Habitability, Efficiency, Survivability.	4
	Operational Tactical Elements	Combat effectiveness influenced by man-machine interaction: Navigation, Search, Time of first salvo, Ops. research at sea.	7

TABLE 1 SUMMARY OF SUBJECTS COVERED IN THE SAMPLE. (CONT'D.)			
Force	Automated Control Systems-ASUV	Debate over how far computers can replace man in the loop.	2
	Force Staff combat effectiveness	Staff's role and tactics in positioning SSN's and SSBN's in firing stations. Training staffs for combat.	2
	U.S. Nuclear First Strike Ability	Why aircraft carriers and AWACS are first-strike strategic systems.	1

E. SUMMARY OF RESULTS

Overall: Systems theory is pervasive and underlies the analyses of effectiveness.[2] Control of any level of system is the ultimate measure of effectiveness. An officer controls his subordinates, a commanding officer controls the decisions aboard ship, the force commander controls the timing and movement of all units under his command.

Individual Level: Individuals are important to the decision support systems as technicians and specialists providing parts to the mosaic of probability for command decision-making. The basic measure of individual effectiveness is the time they take to complete their task. There is sustained emphasis on reducing the time of tasks in order to win the "battle for the first salvo".

Subunit Level: Group functions of the sub-unit are also measured against time norms, striving for reduced times until the sub-unit meets or exceeds empirically established standards ("norms"). For example, the ASW team supports the ship C.O.

[2]For more information on Soviet systems theory and its military applications see Taylor (1983) or Powell and Taylor (1983).

by providing acoustic analyses, search recommendations, and intelligence reports. The decision to act in any particular case is the C.O.'s. His competence (and longevity) depends on how close he comes to the scientifically substantiated action. The articles show consistently that decision-making is constantly reinforced by operations analysis *in situ*.

Unit Level: "One-man command" means that the commanding officer is responsible for choosing the correct tactical action. If he doesn't, he has not applied his years of training and education in dialectics correctly. Thus, only the commander is responsible for the consequences. "Creativity in decision-making" may seem out of the question in such an environment, but the "creative decision" is precisely defined by Soviet writers. A "creative decision" is one made in the face of an ambiguous or indefinite mission, ambiguous or absent procedures, or indefinite measures of effectiveness resulting in uncertain decision criteria.

At the unit level, ships are viewed in two branches of effectiveness; engineered attributes ("tactical-technical characteristics") and man-machine attributes ("operational-tactical factors"). The terminology was consistently followed throughout the articles, indicating that these major divisions of unit utility are the standard. The Soviets define concepts like habitability in terms of empirical crew endurance: a man-machine attribute. Survivability, on the other hand, is conceptualized in terms from both branches of unit utility. In a single unit controlling battle damage, survivability is a function of engineering features. For a unit in a group of ships though, survivability depends on how long the ship continues to fire ordnance after it's hit.

Another unit level concern is the man-machine interaction and speeding up the decision-making process by computerizing the nomograms and hand calculations used aboard ships. Soviet Naval Science is supposed to find ways to operationalize and automate human functions now used to make tactical recommendations to the the commanding officer. Although there is no information on the state of technology currently in the Soviet fleets, the goal of their work is clearly agreed: computers running the correct algorithms give the command decision-maker a substantial tactical time advantage over their enemy. In modern missile warfare, the Soviets want to reduce decision-making time to the absolute minimum. The critical time they all agree must be beaten is the enemy's missile flight time.

Force Level: The effectiveness concepts from the lower levels accumulate in the force level. Squadron or flotilla (or whatever the correct term is) utility is now

contingent on intelligence, stealth, reconnaissance, and the force commander's decision-making. But, the effectiveness of tactical employment depends on the decision support of the force staff. The force staff's competence and experience is the major factor in measuring force decision-making. The tactical and strategic acumen of the force commander is measured against a standard set of correct decisions.

II. THE INDIVIDUAL LEVEL

Of the twenty-two articles chosen from *Morskoy Sbornik* two deal with individual measures of effectiveness. A. Ganin's 1978 article, "Planning, Evaluation, and Analysis of Personal Work", describes a form for ship's officers to use for time management.

In motivating officers to monitor their personal time, he notes that increasing their efficiency increases that of society as a whole. A component of the labor of society is personal work. The phases of planning, evaluating, and analyzing work are the same for all levels and in this way planning work alone is not enough. One has to

- *monitor* work's progress.
- *account* for time losses.
- *analyze* results achieved.
- *identify* deficiencies.

The author presents a form for effectively monitoring, analyzing, and executing personal work. Figures 2.1, 2.2, 2.3 are his suggested accounting procedures for officers to use.

Captain 1st Rank Engineer Salata and Candidate of Psychological Sciences Viktorov suggest a different individual measure of effectiveness in their 1981 article, "Operator Training for Ship Officers". Starting with the premise that operators of ship's equipment constitute a "man-machine" system, they maintain that the most effective use of the system occurs when "specific psychological traits of the operator and technical characteristics of the system are well matched". This effective interaction occurs when the "human factors " are considered.

The authors address another factor in conditioning the operator to his machine. Conditioning comes from managing the process or object and consists of:

- "Changing certain parameters in his memory."
- Becoming familiar with the machine's reactions to operator control actions.
- "Receiving information on different values and combinations of system-monitored parameters"
- "Becoming aware of the time characteristics of certain processes."
- Isolating from the full flow of information only that needed at the moment."
- "Constructing routines to search for the needed information."

Weekly Planning from ___ to ___December 1978, 4th Week.

Time Expenditure Categories:

I.PLAN From Plan of Month.	Jobs Which Crop Up...	II.CONTROL Who,What, Where,When to Control & Monitor.	III.DON'T FORGET Non-operational Matters Which Don't Take a Lot of Time
IA	IB	II	III
Job Hours 1. Jobs of a productive, scientific, or social nature.	Job Hours	Job Hours 1. Names/date assigned/ date to finish.	Job Hours
Time Spent			

WEEK'S SUMMARY:

Jobs worked but not finished (hours by category).

IA(_) IB(_) II(_) III(_)

Summary of work accomplished (hours/percent)

IA(_/_) IB(_/_) II(_/_) III(_/_)

Evaluation: note deficiencies to correct.

(Suggested norms: Category IA & IB: 60-70% completion.
Category II: 15-20% completion.
Category III: 15-20% completion.)

Figure 2.1 Weekly Planning Form

"In short, the operator acquires the specific psycho-physiological traits necessary for the work and refines them."

For example, ship operators working with electronic equipment "perform the following functions during the *control process*":

- radar and sonar operators detect, classify, and localize objects.
- "Specialists who analyze and summarize information on the surrounding situation"(operations specialists in USN terms) post information on nautical charts or plotting boards, determine detected object's motion, and analyze and summarize information for the report to the commander.
- "Navigational support specialists" calculate the ship's course by means of automatic plotters or manually, determine position with computers or individual instruments, and correct radio navigation and other ship navigation equipment.

Time of Day Plan																	
___December Monday				Fill out hours spent													
	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
	Check plan of day		Conduct political studies				Lunch		Self Training		Dinner	Party Meeting		Watch			
Category	IA		IA						IB			II			IA		

Figure 2.2 Daily Planning Form Carried on Person

Working Time for the Week (44 hour example)	
Accumulated hours worked from plan	Category
4 to 8 Self-training	IB
12 Specialty Studies	IB
16 Work with Personnel	IA
20 to 24 Party-political Work	II
28 Exercises & Drills	IA
32 to 36 Watch	IA
40 Summarize results	IA
44 Wasted time	III

Figure 2.3 Summary of Weekly Working Time

- Radio operators "receive and decode radio messages and compose and transmit messages".

These functions are further classified by the nature of the "man-machine" control process. The systems are classified as deterministic, non-deterministic, or game-theory. In deterministic systems, functions are governed by pre-assigned algorithm. The operator's activities are subordinate to rigid rules. Information is processed deductively; the operator knows from experience exactly what signals to expect, in what order they will appear, and exactly what actions follow.

Non-deterministic systems are typical of radar and sonar operators because the rules they follow are more complex than deterministic systems. The method of

information processing is "abductive"; the operator draws information out of a central idea. The operator does not know the sequence, type, or timing of the signals that appear.

In game systems, all situations which may arise during the control process are unknown in advance or the number of situations is so great that the response cannot be envisioned ahead of time. The operator must discover a new version of the solution. The operator's activity is heuristic and uses inductive information processing. The game system requires the highest "intellectual and emotional qualities of the operator".

To train operators, one has to understand how knowledge is accumulated. According to Salata and Viktorov, knowledge is accumulated in memory. Psychologically though, knowledge has two forms of concern to the trainer: images (graphic representations) or concepts ("abstract and generalized reflection of reality"). The operator needs to transform images into concepts and concepts into images. This ability to transform knowledge is the key to regulating the operator. The operator's consciousness contains conceptual models, operational images, and subjective models of the controlled object (radar scope, sonar display) and the environment. The operator's activity is regulated by his consciousness. This is why the trainee needs demonstrations and hands-on training to accompany lectures and diagrams.

Operators possess "skills" on their equipment when they perform actions within certain measures of perfection, quickly, easily, and economically. The operator need not be an automaton to be skilled. There are three types of skills to be considered; sensory-perceptual, motor, and intellectual (that is, problem solving).

Any skill has five stages in its formation, all operators go through these stages as they develop skills in their work. These are:

- Combining a number of elementary movements into a single integrated whole.
- Gradually eliminating unnecessary actions and alleviating tension.
- Switching attention from the process to the result. (A pilot getting in tune with the aircraft.)
- Developing a rhythm of action.
- Developing broad capabilities for arbitrarily changing the pace of work. ("experienced operator switches from one pace to another with ease".)

The system in use for operator training is called the "operation-subject" system. Trainees study what actions to perform as well as performing the work. They receive instruction in words, by demonstration, and by checking results in practice. If a trainee has difficulty mastering the skills, use drill practice to "induce the correct rhythm and

concentration", training exercise to reinforce the sequence of elementary actions, "urgent supplemental information" to train the operator to analyze feedback signals, or types of written instructions. Operators show their ability when performing non-standard tasks; an operator is not competent if he can't apply a certain set of skills under new conditions.

A competent operator must learn to plan his work and realize his own limitations. Part of this competency is regulating his own physiological state, monitoring pulse, blood pressure, muscular tension, etc.. Training includes acquiring emotional stability and self-control.

According to the authors, operators are developed using computer trainers. The algorithms of operator actions for each level of control "are worked out". For example, the algorithm for a ship specialist is based on a simulation of a ship specialist (an OS, in U.S. Navy terms) watching a radar scope indicator and seeing a signal on it. The signal has a random characteristic with four variables; brightness, contrast, length of signal, and repetition from scan to scan. The algorithm registers a detection after two or three scans.

The operator must decide if the signal should be classified as a valid reflection or noise. There are four possibilities:

- Pure detection--correct classification of valid signal as real detection.
- Miss--incorrectly classifying a valid signal as noise.
- Noise--correctly classifying noise as noise.
- False alarm--incorrectly classifying noise as a signal.

The operator can adjust the trainer scope's signal intensity or background noise level. The sensitivity changes alter the probabilities of the type one and two errors.

Emergency training on the simulators presupposes the ability to model emergencies broadly. The operators need to be involved in the etiology of the emergency. This means that trainers have to work out "extensive programs" to disclose the emergency's development. The trainer can proceed through stages of non-standard conditions to train the operator. As the situations become progressively difficult, the operator gains confidence and becomes psychologically prepared for emergencies.

III. SUB-UNIT LEVEL MEASURES OF EFFECTIVENESS.

The sub-unit is equivalent to a U.S. Navy department or division. At this level, groups or individuals act jointly to produce some output, whether the group is an ASW division, a gunnery division, or a bridge watch team. The measures of effectiveness in this section have political sociological or operations research purposes. The subject matter may be different to the American reader, but the Soviet style of problem solving derives its first principles from dialectical materialism. Since the material world is reflected in natural and human activities, research methods are often the same for very different problems.

The first article in this chapter concerns methods for instilling political awareness in servicemen. The next article tells how to calculate the optimal spare parts mix for a ship. ASW team training techniques are the last topics of sub-unit effectiveness in this chapter, but two different articles consider them from the viewpoint of the ship commander and the shore training facility.

A. ANALYZING MILITARY DISCIPLINE

This first article was written in 1975 by two officers who may be political officers. Colonel Pavlov, Candidate of Historical Sciences and Lt. Col. Zaynullin, Candidate of Philosophical Sciences present some general concepts to keep sub-unit's military discipline high. In their piece titled, "Some Methodological Bases for Analyzing Military Discipline", they cite Minister of Defense of the Soviet Union, Marshall A.A. Grechko, in his 1975 speech at the 5th All Services Conference of the Secretaries of Party Organizations. The idea of strict military discipline is reinforced:

> With the rise in complexity of military affairs, decisive importance is acquired by military discipline and strict fulfillment of military regulations and orders. Maintaining a high level of discipline is a necessary condition for the successful execution of the mission facing the Army and the Navy.

The target audience for this article is "Battalion Deputy Commanders for Political Affairs or 3rd Rank Ship Deputy Commanders for Political Affairs" whose responsibilities are outlined in the *Combined Arms Regulations of the U.S.S.R.* (1983). These persons are not subordinate to the ship's 2nd Rank Commander (U.S. Navy

equivalent is Executive Officer) but only subordinate to the 1st Rank Ship Commander (the Commanding Officer in U.S.N. terms), according to Pavlov and Zaynullin.

The 3rd Rank Ship Commander's disciplinary duties include:

> To organize and conduct political work, guiding it in such a way that it would unify the personnel about the Communist Party and the Soviet government and promote successful fulfillment of combat and political training missions, maintenance of the battalion's (ship's) constant combat readiness, fulfillment of combat missions and reinforcement of one-man command, military discipline and the political morale of the personnel.

According to the *Combined Arms Regulations of the U.S.S.R.* (1983, p.155),"The most important prerequisite of the fighting efficiency and combat readiness is high military discipline. Its role is especially great in the attainment of victory in the modern war." Military discipline is defined in the *Combined Arms Regulations of the U.S.S.R.* (1983, p.156) as "the strict and precise observance, by all servicemen, of order and the rules embodied in Soviet laws and military regulations."

High military discipline is achieved, according to the *Combined Arms Regulations* (1983, p.156),

> by instilling in servicemen a communist world outlook, high moral and political and fighting qualities and conscious obedience to commanders (superiors),. . . by maintenance of strict order in the unit (aboard ship in the subunit). . . by the daily exactingness of commanders (superiors) toward subordinates, respect for their personal dignity, constant concern for them and a competent combination and a correct application of persuasion and compulsion.

Col. Pavlov and Lt. Col. Zaynullin note that the effectiveness of the day-to-day adherence to military discipline increases when it is taught to servicemen through a "deep analysis of the statutes of military discipline". But discipline fails when servicemen commit offenses. When this happens, the main goal is to uncover the causal relationship between offenses of the servicemen and the motives behind the offense. Understanding why discipline problems arise makes it possible to develop programs for units and subunits.

To develop a comprehensive approach to analyzing military discipline failures, the authors advise following the rules in Table 2.

The authors give examples of what they mean by discipline indicators in their story about Aviation Unit X. The commander and the political worker (the *zampolit*) found through talking with their troublemakers that they rarely attended political

TABLE 2

RULES FOR ANALYZING DISCIPLINE.

1. Maintain a differentiated approach to analysis:

a. Differentiate places activities where discipline problems arise. Monitor activities of:
(i) leading sub-units state of discipline.
(ii) among junior commanders and activists.
(iii) the level of execution in using combat equipment on a cruise.
(iv) standing guard and shipboard duty.
(v) studying gross offenses dangerous to combat readiness.
(vi) studying widespread violations.

b. Study the effectiveness of political-educational work on ship and the personal example of Komsomol and Communist Party members.
c. Study the personal example of the commander and political workers separately from one another.
d. From this study one can tell which personnel need more work and the reason for their lack of discipline.

2. Analyze the effectiveness of discipline daily.

3. Keep organized records, develop own uniform indicators so one can catch problems in time.

classes, read newspapers, had poor knowledge of current events, and didn't participate in socialist competition.

To correct these deficiencies, the political officer should:

- Keep political activity attendance records.
- Keep track of who uses the library.

The reasons for poor attendance at political classes can be poorly organized, ill considered work-crews which afford certain men no time to attend the meetings. Careful planning by sub-unit commanders can avoid that problem.

The most objective measure of military discipline is the unit's *Combat Readiness.* Well organized daily routines create successful conditions for discipline. Military order is the main criterion for judging discipline.

Military order is measured by:

- Cleanliness and order in crew's spaces (whether their once-a-week laundry is enforced).
- The external appearance of the crew (whether their once weekly bathing schedule is observed).

- The proper rendering of salutes.
- The result of combat and political training.
- The prompt execution of the daily routine throughout the ship and sub-units.

Compare the unit's order as it corresponds to regulations. (The bathing and laundry regulations, for instance, are found in Chapter 14 of the *Combined Arms Regulations of the U.S.S.R.*). Question "fighting men" on their knowledge of regulations. How many violations are there and how serious are they ?

Once the state of discipline is understood, find out why the offenses occur. In general, there are three reasons for offenses.

- "Individual peculiarities of fighting men."
- Shortcomings at the sub-unit level.
- Shortcoming of the collective as a whole.

The individual peculiarities of fighting men involve individual character traits such as, a low level of conscientiousness or responsibility, insufficient understanding of their military duties, negative character traits and bad habits, evasiveness, selfishness, lack of self-control, obstinacy, lack of spirit, and susceptibility to bad influences.

The shortcoming of the sub-unit include weaknesses in the commander, political workers, Party and Komsomol organs, weak superior's demands, distortion of disciplinary practices, low level of political educational work, poor work style, and ineffective discipline.

The entire "collective" may have shortcomings like the absence of effective public opinion molding the correct behavior, mutual concealment, low morale in the collective, psychological incompatibility of individual men, disunity of people, or a situation of all-forgiveness in the unit.

After the political officer has completed the analysis of discipline and discovered the reasons for offenses, he must define ways to correct and strengthen discipline. The current frequency for determining discipline is quarterly and monthly for the whole unit and weekly for the sub-unit.

B. DETERMINING THE BEST SPARE PARTS MIX

Moving from the political officer's realm, there are other sub-unit measures of effectiveness to be explored. Captain 2nd Rank Engineer G. Trofimov explains how to determine the optimum composition of spare parts in the 1979 article, "Calculating the Composition of ZIP". ZIP are the spare parts, instruments, and accessories carried on

board Soviet Naval vessels to repair "technological equipment" (basically anything manufactured is considered technological equipment).

Captain 2nd Rank Engineer Trofimov presents a dynamic programming method suitable for computer applications. Other methods like probability theory, queuing theory, and mathematical programming have potential errors as high as fifty percent, he says. Dynamic programming is an accurate method but the calculations prove burdensome if there are many constraints. If there is just one constraint, dynamic programming is useful and in practice there usually is just one constraint, like weight or volume.

Dynamic programming allows modelling the probability of needing a part under certain conditions. Accurate calculation of ZIP composition can be especially important for "ships going on long deployment". The actual calculations would probably be done by computer once the algorithm has been set up.

The author defines "optimal composition of ZIP" as a set of diverse spare parts containing a minimum number of units of each type and strictly limited by a maximum weight (in the case of a weight constraint) for a given period of operation with a maximum probability that any spare part needed to replace a failed part will be found in ZIP. In other words, this is a dual objective problem; minimize quantity and maximize probability of success for a fixed time period and weight.

The rest of the article derives the dynamic programming method and computes an example with six parts. The key point to compare here is that the Soviet supply officer must have a good idea of failure rates for each spare part in order to use this method. The data could easily come from the central manufacturing points for each part, but whether anyone actually calculates the optimal ZIP at this level is unknown. The force or fleet staff logistics officer might run this calculation before ships head out for their Caribbean, Indian Ocean, or African deployments.

C. EVALUATING SHIP'S ASW TEAMS

Antisubmarine Warfare (ASW) is an important naval warfare area for the Soviet Navy and there are two articles in the sub-unit sample dealing with training ASW teams. In the 1978 article by Captain 1st Rank Sil'chenko, Captain 3rd Rank Chausov, and Captain 3rd Rank Ancharov, "The Central Link in an ASW Team", a broad range of factors in the effective shipboard training of all the players in ASW eventually

depend on the central link.[3] the ship's commanding officer who is the central link because:

> on the thoroughness and practicality with which he personally trains his men at all stages of their instruction depends the precise coordination of all elements and the preparedness of the ship as a whole to perform the mission of locating, tracking down and destroying a submarine.

The ASW team's success depends on the commanding officer's expertise and professional knowledge of ASW, for as soon as individual training ends, the C.O. shapes the ASW team. This team consists of the entire ship, arrayed as specialists, with sonarmen as the key players. As the authors point out, "the success of the whole team's effort depends to a great extent on how well the sonarmen are trained." The sonarmen's station and the main control center[4] have to practice cooperation. One factor the C.O. should watch for is not covered in any document. He should get to know the individual 'style' of each sonarman, recognize each man's special abilities and weaknesses. The article does not specify further how this style manifests itself, but it probably shows up in sonarmen's ability on different types of sonar equipment. Some technicians have very sensitive hearing, others are adept at reading Fourier analyses. The individual's natural ability plays a role in determining his style.

The authors advocate drills and exercises at sea; sonarmen can get too much sonar theory and not enough training in "the special nature of the work at any particular station." Shore based trainers are fine as long as conditions are realistic. Most important, the authors say, the C.O. has to direct the training because only he can decide how a sonar station should be utilized during tracking or search. The sonarmen need training in the "characteristic features of the identifying signs of various targets, and others, without knowledge of which they might as well not put to sea."

The level of organization above the sonarmen is the ASW team. Their functions are manifold and the personnel manning the ASW team come from several ratings and officer specialties. The basic jobs of the ASW team are to:

- Evaluate conditions and circumstances.

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[3]Central Link: a term coined in 1902 by Lenin to connote the key factor, in a complex set of factors, which once understood as that key to the complex, can be controlled to control the entire system. Since "central link" is a Leninist term, its connotation is probably well known to the *Morskoy Sbornik* audience. Source: Judith Grange, SAIC. Lecture at Naval Postgraduate School, Nov. 7, 1986.

[4]A concept similar to CIC-but more specifically devoted to facilitating the C.O.'s *control* of the battle than to just providing information on the environment.

- Make the decision to search for a submarine.
- Detect a submarine.
- Identify the contact.
- Destroy the target.

Each of these stages has a profound functional difference in terms of the ASW team's actions. The authors explain the key tasks of each stage.

Evaluating conditions and circumstances means analyzing hydrologic information, understanding intelligence reports on a submarine's probable maneuvers, processing this information, and making calculations. The C.O. leads a highly specialized team of officers who process the information on conditions and circumstances, make the calculations, and prepare essential data. The officer specialists' goal is to provide the best information for making a decision on when to search. The C.O. may wish to prepare a list of questions for each specialist to consider in this phase, however,"..these must not be presented always in a rigidly fixed pattern; this might paralyze the team's initiative and creativity". It's up to the C.O. to keep this team alert, giving them problems to work out so the team is ready to respond immediately. The picture the authors convey of the C.O. receiving all of this refined input data in order to reach a logical decision is very similar to that which we see later when talking about the force commander receiving staff support for decision-making.

The decision to search is the C.O.'s alone, but it is built on combining the specialists' reports on deciding when and how to search. The implication in this stage of the ASW team's work is that the decision to search means energizing the active sonar. This stage may last minutes or hours, but the ASW team must be ready to proceed immediately into the next stage upon detection. Once again though, individual officer specialists are key advisors to the C.O. and may recommend such actions as search patterns, sonar beam forms or frequencies, search speeds, search areas, and length of search before breaking off. This stage concludes rapidly when a sonar contact appears.

The detection and classification stage is limited by time. The limits are set by the rapid change in the tactical situation, reciprocal maneuvering of ship and target, and use of countermeasures and jamming. The C.O.'s job in this environment is also time limited, for he must:

- Quickly and correctly classify the target.
- Distinguish the submarine from other targets by its unique signature.

- Coordinate sonar stations and 'command posts' for collection and processing of classifying signs.
- Make a final decision, based on computations, whether to attack and so order weapons stations into action.

The authors provide an example of how the C.O. would use this ASW team when he is given the target's course and speed. The C.O. determines the validity of the "classifying sign" (some kind of acoustic signal) based on his years of experience.[5] The C.O. also compares current intelligence with the classifying signs. He determines whether other acoustic means show a different course and speed. When these factors have all been considered, the C.O. decides whether or not to classify the contact as a submarine.

The classification stage of the ASW team's work is difficult but

> many years experience in training under diverse environmental conditions, both at base and sea, make it possible to identify the characteristic signs of diverse underwater targets, to compile a collection of photographs of sonar station screens and magnetic tape recordings of echo signals. Under the direction of the commanding officer, detailed descriptions of the classifying signs are worked out for every type of detection device. In the course of exercises and cruises in various areas, these are supplemented and corrected.

The commanding officer decides the relative importance of each classifying sign through a statistical treatment of many contact detections and classifications. For example, assume there are five most typical signs from a given means of detection, each sign varying in frequency of appearance. The following illustration, Figure 3.1, shows how the data are reduced to a tactical table for the C.O..

The commanding officer of the ASW ship has these probabilities of submarine presence built into a summary table for reference during the classification stage of the ASW work. The authors show such a classification table in their article, reproduced here as Table 3. They describe a decision-making process structured as follows: the ASW team evaluates the classification signs of the echo-contacts and reports the results to the C.O.. The C.O. evaluates the total probability of submarine presence using a form of Table 3. This method reduces by "twenty to thirty percent" the time to classify a contact. Since the C.O. has more confidence in his classification, he also has more confidence in picking the correct ordnance for an attack.

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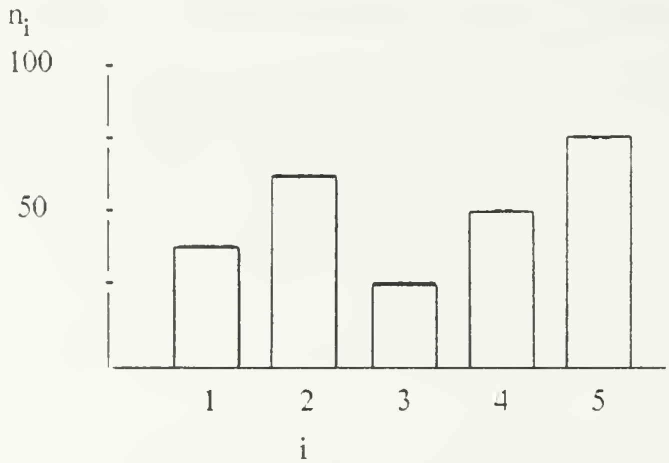
[5]The average command tour lasts five years on Soviet frigates. *Understanding Soviet Naval Developments*, p.66.



P_i(submarine present) = n_i / N

Where:

N = total number of classifications evaluated.

n_i = frequency of appearance of classification sign i.

P_i = probability of a submarine's presence when classification sign i has been received.

Figure 3.1 Submarine Detection Probability Table

TABLE 3

TACTICAL SUBMARINE CLASSIFICATION TABLE

Classification Signs	P_i	$\sum P_i$ Total Probability of Submarine's Presence
1	.37	.37
2	.64	.77
3	.23	.82
4	.51	.92
5	.75	.98

Lastly, the ASW team must be psychologically trained to endure long hours of monotonous, exhausting work in rough seas and bad weather. The Commanding Officer has to prepare himself and his team to accept a reasonable risk in the successful leadership of ASW.

D. THE EFFECTIVENESS OF SHORE BASED ASW TRAINING

The shipboard ASW team doesn't come directly out of recruit training ready to go to sea and find submarines. On the contrary, the 1976 article in *Morskoy Sbornik*, "Assessing Effectiveness of Shore Training of ASW Teams" by the same two junior authors, Captain 3rd Rank Chausov and then Captain-Lieutenant Ancharov, as the previous section's 1978 article, discusses in detail ashore preparation for shipboard operations.

ASW shore trainers ("base training") are apparently widespread. Trainers and drill/practice training devices provide the Soviet Navy with realistic scenarios without expending ordnance or adding hours of operating time to equipment. Trainees with "technical gear" and "programmed training methods" achieve several objectives:

- "make it possible to assimilate material more thoroughly."
- "produce firm practical skills."
- "shortens training time for specialists and increases the knowledge they acquire."
- increases qualitative indicators of the training process.

Based on this article, there is apparently a consensus in the Soviet Navy on how to measure ASW shore training effectiveness. The first step in analyzing the effectiveness of training is recognizing that the ship's ASW team is a "multilevel system". Picturing it this way facilitates the preparation and assessment of effectiveness measures from the lowest to the highest levels of the ASW team. Figure 3.2 shows the levels of the system as the authors describe it.

With the general system in mind, the authors begin their discussion of training techniques at the lowest level, that of the operator at a battle station. The first task is for the operator to practice *norms*. Norms in general are defined in the *Great Soviet Encyclopedia* as "the minimum of something, as established by a rule or plan, for example, a time norm or a sowing norm."[6]

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[6]*Great Soviet Encyclopedia*, Vol.18, p. 257(1).

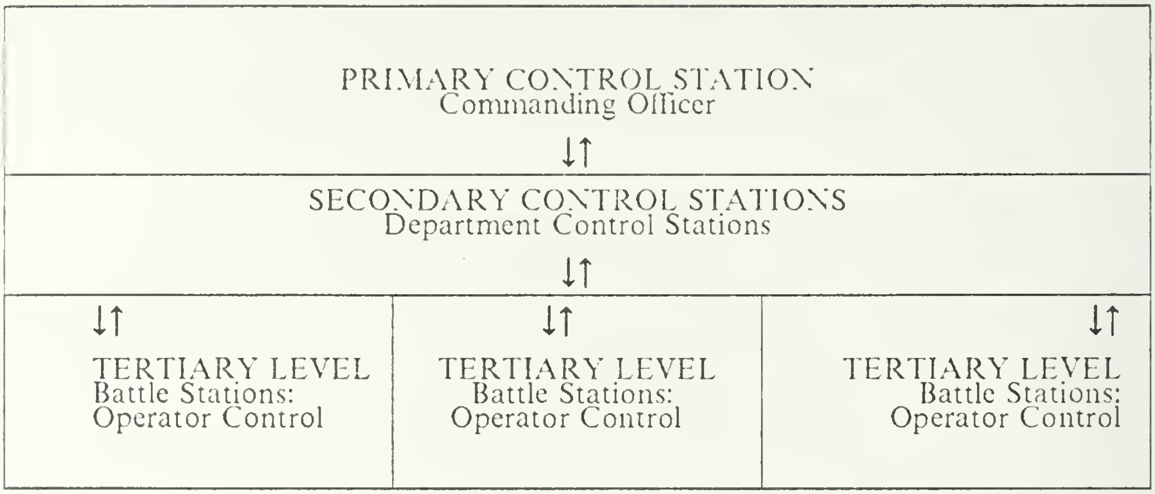

Figure 3.2 The Embedded Systems in an ASW Team.

Practicing norms eliminates mistakes on individual operations (like pushing the wrong button) and reduces superfluous movements. Thus, elapsed time for operator actions is reduced and stabilized around the norm. "The need for visual control over correctness of movements disappears" because the operator can focus his attention on the results at the console instead of the intermediate steps. Fatigue is also reduced.

The operator's skills are shaped in four stages of conditioning. The first stage is to comprehend the actions at the console. The trainee has a clear understanding of the objective of his action but is unsure how to attain it. For example, an operator may recognize excessive noise on a display but not know which knob reduces noise. The second stage consists of conscious but clumsy actions. "The operator works intensely, makes many superfluous movements, and is constrained. . . .by all attention directed at monitoring himself." The third stage shows improvement. The operator demonstrates confidence, swiftness, and a declining error rate. The constraint (time constraint, possibly) and tension disappear. Attention shifts to the result of the work. The fourth and final stage in skill shaping occurs when the operator performs swiftly and precisely. He has released all attention from monitoring actions. At this skill level, the operator is ready to work exercises as part of the ship's ASW team.

These skill shaping stages do not just apply to individual operators. "Battle Stations" and other groups are also measured against norms of training. Figure 3.3, from the article, shows the learning curves for individual and team training. The Roman numerals inside each graph correspond to the four stages of skill shaping just

discussed. Judging from these curves, the Soviets have fairly precise data on their operator and team training for ASW.

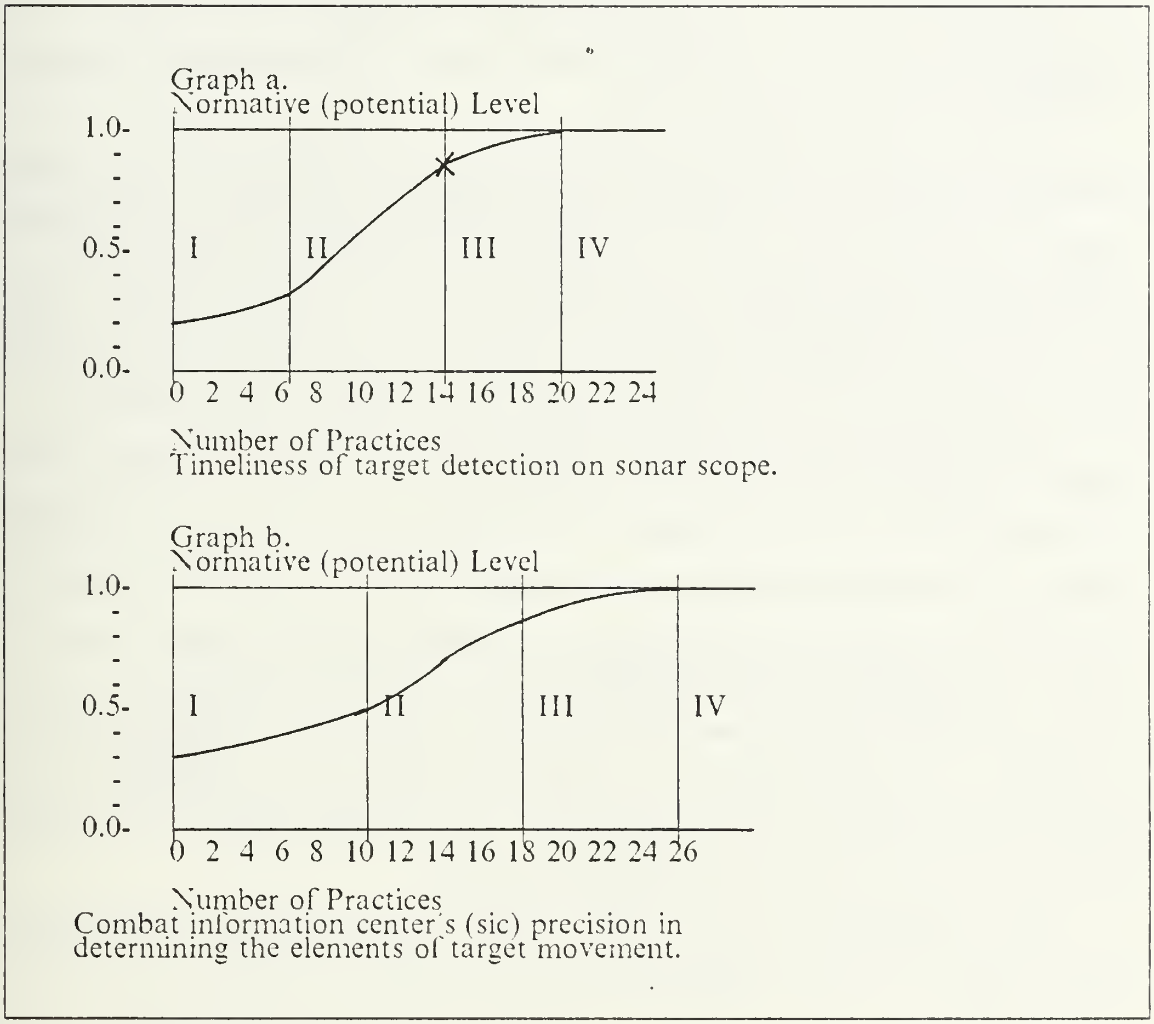

Figure 3.3 Learning Curves for ASW Training

Training of the battle station team begins when the number of training practices reaches an empirically determined level of attainment, as Figure 3.3 shows. The authors say that operators begin training with the entire ASW team when they have reached the third stage of skill formation. The beginner's readiness to practice with the group is assured when he has completed seventy-five to seventy-eight percent of the normative number of practices. This crossover point is marked as as "x" on the boundary between zone II and III in Figure 3.3, graph "a".

The group training stage begins with emphasis on "the organization of communications and coordination of control points and battle stations, skills of analysis and generalization of the data received, forming conclusions from an estimate of the situation . . . and use of data for possible correction of the decision which has been made." In short, the ASW team learns from the beginning how to support the commander's decision-making process.

In early team training, the ASW team goes through structured scenarios, performing standard actions determined by "guideline documents". These documents specify the proper decision which each level of the ASW team should reach in the training session. The measure of team effectiveness here is comparing their "precision of action" with the established norms. The team score is a composite of the individual scores. There are two theoretical approaches in use, experimental and analytical.

The experimental method uses empirical data and "requires a large volume of statistical material on each task being accomplished." The analytical method compares the potential with the attained level of team performance. There are some general indicators for analysis including, operator performance, timeliness, and coordination precision. For example, trainers time an ASW team until they reach a decision on a canned problem. Their time is compared to the "potential level", W_p, the value of a norm for each level of the team in that problem. These W_p's are found from "tactical techniques" like maneuvering board solutions or target motion analysis (TMA) and from "technical facilities" like sonar scopes, signal analyzers, and other equipment where operators interpret the presentation of a screen.

The "attainable level", W_r, in this analytical scoring method is derived for a specific stage in training from Equation 3.1.

$$W_r = \sum_i^k O_i\alpha + \sum_i^l O_i\beta + \sum_i^m O_i\gamma \qquad \text{(eqn 3.1)}$$

$O_i\alpha$, β, and γ are the operation performance measurements for the I, II, and III stages of ASW team training, corresponding to the three level system of shipboard ASW control (α for the C.O., β for secondary control, etc.). The indices k, l, and m represent the number of operations assessed at each level. The potential level calculation, W_p, is shown in Equation 3.2.

$$W_p = 5\,(k + l + m) \qquad \text{(eqn 3.2)}$$

The '5' comes from the training center's 5 point grading scale. Finally, the composite team score which indicates the generalized training level of the ASW team is simply the ratio of W_r and W_p, as shown in Equation 3.3.

$$K_p = W_r / W_p \qquad \text{(eqn 3.3)}$$

For an ASW team to be ready to go to sea, $K_p = 0.8$ and there must be no unsatisfactory marks for individual operations.

The authors demonstrate how they would score a sample submarine classification training session. The process is broken down into three components; detecting the return, analyzing the classification signs, and making the classification decision. For each component step they list the operations that every level of the system will perform. Figure 3.4 shows how they might actually record the results of one stage of training.

TRAINING OBJECTIVE: Practice Submarine Classification STAGE OF TRAINING: 2) Determine Classification Signs
ASW TEAM LEVEL: 1) Commanding Officer/Main Control Center
OPERATION*: 6) Maneuver ship to classify contact. ACTION TAKEN: C.O. decides to maintain position.
*(In the notation developed this is $O_6\alpha$) The potential score, W_p for $O_6\alpha$ is 5 for increasing range 4 for maintaining position 3 for decreasing range In this case, the Commanding Officer scores 4 points.

Figure 3.4 Training Performance Score Card

The scores for every level of the system, at each stage of the training process, are calculated similarly. Finally, the authors emphasize that this method is adaptable to manual and automated training devices.

IV. UNIT LEVEL MEASURES OF EFFECTIVENESS

Most articles gathered from *Morskoy Sbornik* concern effectiveness of the unit. Eleven of the twenty-two articles in the entire sample deal with subjects structured around the ship or aircraft. This does not mean that differentiating between functional areas of a ship stops at the unit level. There are definite functional boundaries in the analysis of ship utility. These boundaries are defined by Khudyakov (1981) and echoed throughout the articles from *Morskoy Sbornik*.

There are two primary categories of ship utility at the unit level. They are "tactical technical characteristics" (TTC) and "operative-tactical factors". These categories are linked to the effectiveness they are designed to measure. TTC's are factors of combat effectiveness due to equipment, design, and technology of a ship. Operative-tactical factors are indicators of combat effectiveness derived from operations research of training, force control, and tactics. As the term implies, operative-tactical factors are measured at the level of combat where tactical or operational actions occur.

Tactical-technical characteristics stem from two components called "tactical-technical elements" (TTE) and "technical design parameters" (TDP). In Khudyakov's words,

> By TTE we mean the characteristics which directly influence the combat effectiveness of the ship, that is directly enter into the algorithms for directly calculating the combat effectiveness index as initial data. (Khudyakov, 1981, p.14)

Examples of TTE are:

- maximum speed
- endurance at sea
- cruising range
- principal dimensions
- handling characteristics
- stealth characteristics
- protection
- reliability
- invulnerability

TDP are characteristics which indirectly influence the effectiveness indexes. Khudyakov(1981) gives these examples of TDP:

- structure and architectural design of the hull.
- class and characteristics of the powerplant.
- electrical power system and capacity
- type of hull material

The articles about TTC include discussions on damage control and survivability, cruising endurance and habitability, engineering plant indicators of efficient ship use, and efficient use of shipboard equipment. In other words, TTE's and TDP's.

Most of the articles described in this chapter deal with operative-tactical factors. Whether the Main Naval Staff wants the Soviet Naval Officer to get operational experience and thus has publishes more articles on the subject, or whether the writers for *Morskoy Sbornik* simply have more operative-tactical material to convey is difficult to assess. But Khudyakov's ideas on the subject of operative-tactical factors may show its relative importance.

> The operative-tactical area pertains to the combat use of the ship as an element of the system of mixed forces of the fleet called on to solve one problem or the other. (Khudyakov, 1981, p.4)

Operative-tactical factors figure directly in the unit's effectiveness in combined-arms actions, and are the important factors to Fleet Staffs in planning the employment of combined-arms actions. The subjects of the seven articles include directional ASW searches using stochastic modelling, navigation accuracy of the dead reckoning track, tactical development in the fleet, seamanship under ice, ship control systems and decision making, and decision-making and risk.

Figure 4.1 shows my interpretation of Khudyakov's components of ship design. This hierarchy is embedded in the following articles, which apply these concepts to Soviet ship utility.

A. UNIT LEVEL TACTICAL- TECHNICAL ELEMENTS

1. Engineering Plant Effectiveness

In the 1975 article "Quantitative Indicators in the Operation of a Ship", Captain 2nd Rank-Engineer Candidate of Technical Sciences N. Dorogovtsev, describes how to "objectively evaluate by quantitative indicators" the effectiveness of a

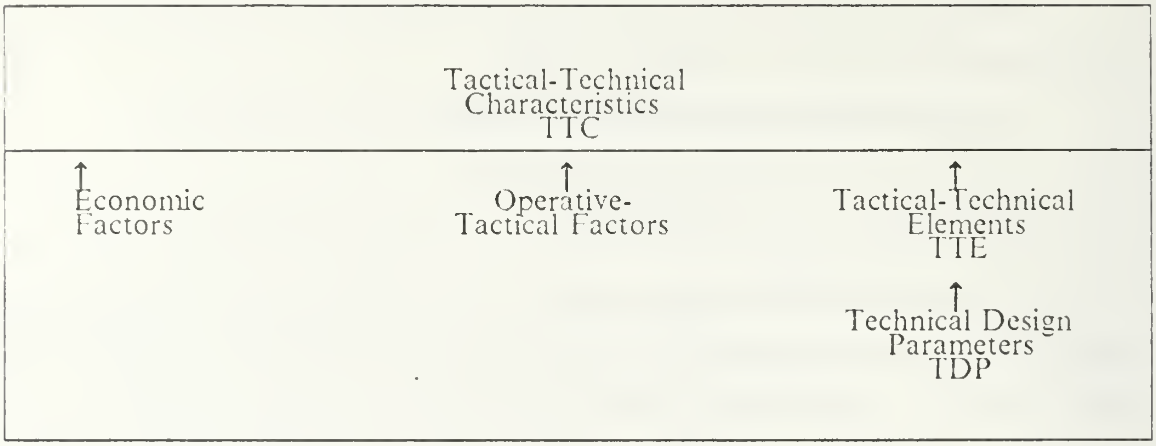

Figure 4.1 Hierarchy of Unit Level Utility Factors.

ship's "technical equipment". In this context, "technical equipment" means the engineering propulsion plant and power generators. These indicators are gathered to rationally plan and analyze the employment of the engineering plant.

These indicators, derived from engineering plant parameters, are compared statistically within similar ship types employed on similar missions. *Normative* parameters are "discovered" and then used by ship engineers and shore staffs to evaluate the best performing plants and crews. In this way, the "progressive experience" of one ship can be shared with all units.

Dorogovtsev presents the following indicators: *The time the engineering department spends preparing for and passing "ship type and special" inspections.* This indicator measures the "organizational activity of the supervisory personnel" in the department, provides a basis for comparing the management of different ship's departments, and enables forces and fleets to refine their scheduled inspection times.

Boiler life depletion when the ship joins the forces afloat. That is, how many hours of steaming are required to pass the builder's trials and get the shakedown trials completed so the ship can become operational ?

The ship employment indicator evaluates the intensity of ship employment. It is found by this formula: Number of days underway / Number days employed.

The engineering plant employment indicator evaluates the intensity of employment and the status of the steaming plant: Miles steamed / Days employed.

Average ship speed in one employment period is another measure of wear on the plant: Miles steamed / Hours underway.

The service life depletion of main and auxiliary machinery measures the rate at which each machine is approaching its service life: Hours per machine / {Hours underway}{Number of machines each type}.

Average operating time of each main engine with no load. For diesel and gas turbines: Number hours operating unloaded/$\sum$operating hours. For steam ships: Number hours operating with main engines warmed up/$\sum$operating hours.

Fuel economy is: Fuel consumed/Miles steamed.

Dorogovtsev shows several measures of the effectiveness of maintenance, both planned maintenance and corrective maintenance. Each measure describes an aspect of the unit's ability to maintain the State's equipment.

The first of these measures characterizes *how well the ship complies with scheduled* (i.e., *planned*) *maintenance requirements* and describes the quality of that scheduled work: Number of days in scheduled machinery inspections / Number days employed.

The number of man days spent in maintenance establishes the man-hour norm and "makes it possible to evaluate the possibility of reducing the labor" devoted to scheduled maintenance: {Number of men}{Days in scheduled maintenance} / Number days employed.

Planned machinery overhaul is apparently a separate category of Soviet Naval maintenance, for Dorogovtsev provides a separate measure for overhaul. The implication is that the ship's company overhauls some machinery themselves. Depending on the scale of these overhauls, this could represent a significant difference from the U.S. Navy's practice of having shipyard workers instead of ship crews overhaul machinery like boilers, pumps, and motors. *The scheduled overhaul measure* is given by: Number days spent overhauling machinery / Number days employed.

The cost of these scheduled overhauls is used to measure and establish the "volume" of work performed and "makes it possible to reliably allocate funds for repair of identical ship types". This is measured by rubles spent in overhaul.

Repairing machinery when it breaks or "unscheduled maintenance" is the other side of operating equipment. The single indicator given to measure the *crew's skill and effectiveness in correcting damage and casualties* is a gross measure of the number of days damage or casualties idled the ship: Number days unable to perform mission /Number of days employed.

measures are interesting in themselves but Dorogovtsev goes a step furtheres the *norms* for the indicators of main engine life depletion, diesel genera:e life depletion, and fuel economy. The rationales for these norms reveal he reasons for Soviet ships spending a high percentage of deployed ship time atnstead of underway.[7]

rm for main engine life depletion is broken down by number of shafts and tyer plant:

- gine Diesel plant: 1.1 hour / hour underway.
- shaft plants: ≥ 0.5 hours / hour underway.
- ıft plants: ≥ 0.33 hour per engine / hour underway.

When rms are exceeded, Dorogovtsev says this could indicate extended operatisel under no load (a bad practice with marine diesels) or short uses of the ma under partial load. If the indicators come in below these values it shows time lying to or errors in accounting.

icator for diesel generator service life depletion should not exceed 1.0 hour /derway. If this indicator exceeds this value it *shows that the diesel generallso run at anchor.* The author avers that running the generator at anchorıore facilities weren't providing the proper power supply. The writer cannot nd how ships at anchor are supposed to get shore power, so Dorogcelling us that Soviet ships are supposed to shut down their generators at anch

ealm of fuel economy, the indicator is interpreted somewhat similarly to the erator norm and too much fuel consumption means the ship is burning fuel at pierside. High values indicate fouled ship bottoms, hull imperfections, propellms, sailing in storms, combined diesel and gas turbine (CODAG) operatioo much gas turbine boost, simultaneous diesel generator operations with tectrical loads. Finally, high fuel consumption can indicate extended anchorng the main boilers, diesel and gas turbine generators, or other auxiliarent "for providing own needs". Analyzing all of the indicators will easily sher the ship was spending its time at anchor burning fuel or whether the fuelumed underway.

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[7] istance *Understanding Soviet Naval Developments* or *Soviet Naval Diplom:* way deployed Soviet ships operate.

These norms, aners, are analyzed by everyone involved in the unit's operations. The ship's eering officers and force commander's deputy for engineering can "objectiveluate the quality of operation" of the unit's engineering plants, the efficiency of fue oil consumption, and the efficiency of the ship's labor organization. The data havs at all levels, he concludes, after deployment or some characteristic time frame, pnel from the sailor to the force commander should receive the results of the ana to improve the collective's labor.

2. **Habitability as a Ta-Technical Element**

In the 1978 article, Cruising Endurance of Ships and their Habitability", Candidate of Medical Scienc Lomov and co-author Candidate of Military Science I. Raskin begin their report the familiar phrase "from materials in the Soviet and foreign press." This phrase gelly means that some of the ideas are still exploratory but are being discussed by troper authority. This interpretation makes whatever the authors say very ambiguout for our purposes, the 'truth' of what they say is not as important as how they roach the problem of habitability on ships.

The Soviet Navy hasreased the time it stays out of port in the last ten years. The chart in Figure 4.2 n *Understanding Soviet Naval Developments* (1985, p. 21) shows this trend clearly. Lov and Raskin wrote this article in 1978, a period of growing ship-days deployed for Soviet Navy and also a time when the "foreign press", specifically the U.S. Na,vas also thinking about habitability on its new Spruance class destroyers. Thisirpretation implies that the U.S. Navy's own concern with habitability may havdriven the Soviets to think about it. This is probably only partly true but there io conclusive counter evidence. Certainly, as we will see, Lomov and Raskin have a ry different definition of habitability than the U.S. Navy's.

Before turning to the specifiof the Lomov and Raskin article, Khudyakov gives an interesting insight into Soviethinking on the utility of sea endurance. In his 1981 textbook, he describes the cycll concept of unit operations and coins an "operative use coefficient" (KOU). Tlformula for calculating KOU looks at sea endurance as just a factor of how longhe ship spends in the "combat zone", not a measure of how well it provides for the cnfort of the crew. Figure 4.3 is his formula.

With this model of operative usin mind, we return to Lomov and Raskin's discussion of the psycho-physiological faors limiting crew endurance. They first look at the American definition of habitability:

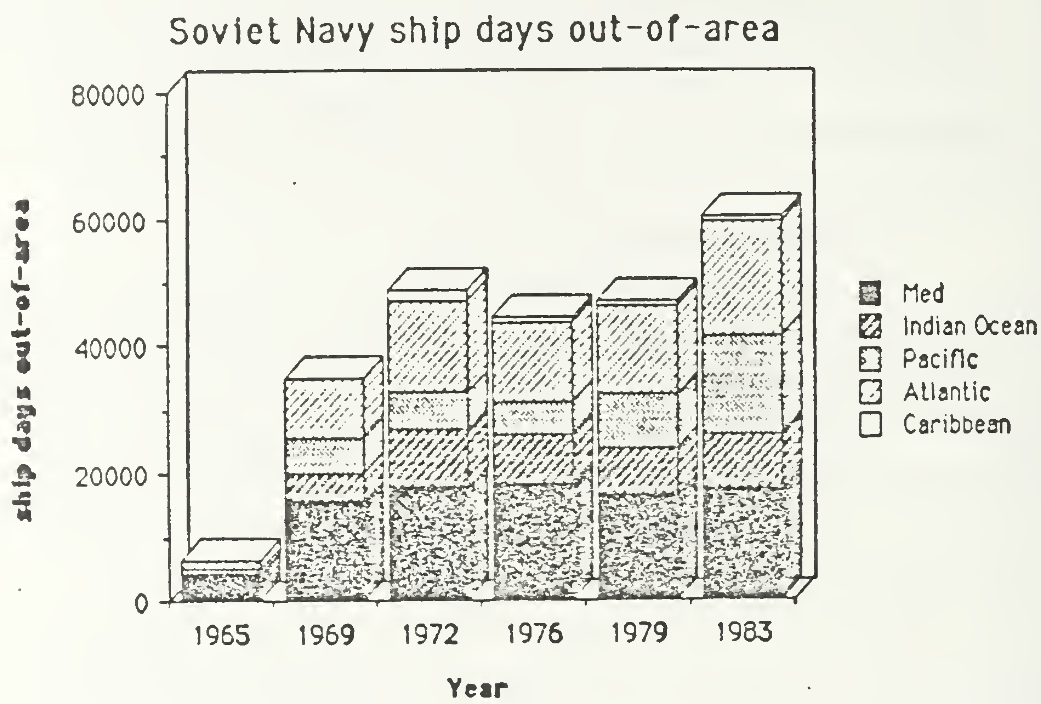


Figure 4.2 Soviet ship days out-of-area.

> The comprehensive interaction of environmental conditions aboard ship with the physical, psychological, and social needs of personnel while they are efficiently performing their military duties...directly related to the working capacity of personnel and consequently to the ship's combat readiness.

Thus, the working capacity of personnel is a first principle to consider. Citing the Soviet experience with the increasing technological sophistication of ships:

> We know that the work of shipboard specialists has become, for the most part, that of operators of technological equipment, and that this has a tendency to increase nervous and emotional tension in those who perform it. The most common characteristic of the activity of naval specialists, foreign researchers observe, is receiving information, drawing logical conclusions from it, making decisions, and giving orders to an automatically controlled system.

$$KOU = \frac{\text{Time ship spends in combat zone}}{\text{Time ship spends at sea and base}}$$

$$KOU = (A/(A+T_i))(1-(2R/(V_t \times A)) \quad \text{for } 2R/(V_t \times A) < 1$$

$$KOU = 0 \quad \text{for } 2R/(V_t \times A) \geq 1$$

Where:

A = sea endurance of ship(time at sea)

R = distance of combat zone from the base

V_t = ship's transit speed to combat zone and back

T_i = time between voyages in base

$A/\{A+T_i\}$ = "operative stress coefficient"

Figure 4.3 Operative Use Coefficient. Source: Khudyakov (1981, p.85)

"Foreign specialists" are having trouble operationalizing habitability. The reason for this, "in our view may be their lack of a single specific criterion for evaluating habitability". These "foreign specialists", Lomov and Raskin continue, are not linking "sea endurance" and "habitability". The point of their article is to define habitability into the "complex of a ship's tactical technical characteristics." Those are Lomov and Raskin's (translated) words, using the same terminology as Khudyakov three years later.

Lomov and Raskin propose a term that links the idea of crew endurance to the rest of the tactical technical characteristics. The term they suggest is *kontinentnost*, from the Latin word 'continentino' meaning continuity. Kontinentnost is defined as the length of time a crew can remain aboard ship continuously at sea in a condition which will enable them to perform assigned duties without long term overexertion. Ship's stays at sea are now limited by kontinentnost because improvements in other technological areas exceed human endurance. Thus, when kontinentnost approaches the limiting time (determined empirically for each ship type), the ship should return to base or have its crew replaced.

The calculation of kontinentnost is based on the empirical crew endurance. For each ship class;

$$\text{KONTINENTNOST} = \frac{\text{Time crew has been aboard ship}}{\text{Ship's cruising endurance}}$$

The authors conclude that even though kontinentnost does not measure all the aspects of habitability as defined in the West, it is more to the point of real concern: warship endurance at sea.

3. Measuring Gas Turbine Efficiency Dialectically

In Captain First Rank Candidate of Technical Sciences M. Abramov and Captain Third Rank Engineer V. Fatin's 1980 *Morskoy Sbornik* article, "The Efficiency of Use of Shipboard Equipment", cluster analysis is the mathematical technique used to evaluate the efficiency of operating gas turbines in eight ships. But the numerical methodology of the article is preceded by a detailed polemic on the proper definition of efficiency. It all starts with the material dialectic.

Efficiency, according to Abramov and Fatin, is an economic category of materialistic dialectics. "Quality" and "efficiency" are equal concepts used to evaluate labor.

> The quality of an article is the aggregate of the properties that stipulate the suitability of articles to satisfy specific needs in accordance with intended purpose.

The quality of equipment depends on characteristic properties which display one particular aspect of the equipment. Examples of properties are operating temperature, fuel consumption, ease of technical maintenance, and covertness. Quality manifests itself in the use of the equipment.

Efficiency is also a characteristic of using equipment, but it is measured over limited time periods. In order to evaluate military-economic efficiency, the equipment being tested must achieve maximum results for a minimum cost. Combat efficiency is measured in terms of maximum results.

In evaluating efficiency, Abramov and Fatin observe a strict hierarchical correspondence between the structure of the system and the process of its use. In other words, the efficiency of any system is directly tied to the system's goals. The efficiency criteria should reflect the end result rather than intermediate steps. A generalized criterion of efficiency takes this idea one step further by simultaneously combining several system indicators. The authors say that a "generalized criterion" is hard to come

by, but that is why they recommend a dynamic programming technique, cluster analysis, and the use of computers.

They apply cluster analysis to determine the efficiency of eight ship's gas turbine power units. The efficiency criteria are fairly straightforward, and even seem to have come from the Dorogovtsev (1975) article on engineering plant indicators. Engine hours are still engine hours, whether or not they have a basis in dialectics. The gas turbine power unit (GTPU) efficiency indicators are:

- K_1 -coefficient of main engine use underway.
- K_2 -coefficient of use of GTPU underway.
- K_3 -coefficient of use of GTPU at anchor.
- K_4 -coefficient of economy of use of main engines.
- K_5 -coefficient of economy of use of GTPU.

The cluster analysis technique sorts the best and worst performing ships by their GTPU coefficients and gives the force staff engineering officer a number for future reference. This technique, the authors maintain, has applications beyond single systems. Such multilevel systems could contain single systems governing signals, ammunition expenditures, and or flow of events. Ultimately, they see cluster analysis as a comparative tool for decision making "useful at any level of management."

4. Damage Control and Ship Survivability

Reserve Captain First Rank-Engineer and Candidate of Technical Sciences, Assistant Professor A. Indeytsev purports to reference Powell (1970) in the *Naval Engineer's Journal* (a publication of the American Society of Naval Engineers). Indeytsev's topic is improving survivability. Powell's is not. The actual title of the Powell article is "Optimum Spares Provisioning Method for Electronic Equipment Systems". In it he addresses a spare part provisioning method optimized for maintainability and least cost. He does not mention damage control.

For example, Indeytsev says:

> With the aid of the systemic approach, Western specialists assert, it is possible to predict how a ship will function in combat (after an accident) and by the same token to give it tactical technical characteristics which will correspond in maximal degree to what is optimal throughout the life cycle of the ship. This method of evaluating its qualities before it is even built provides for the construction of a logical design model of the expected survivability system, which makes it possible to discuss how the elements thereof are related to certain factors affecting the reliable functioning of ordnance and technical equipment when there is battle or accident damage.

The Soviet author overstates Powell's aims when he says "Western specialists assert it is possible to predict how a ship will function in combat (after an accident)". Powell limits his subject to electronic spare parts, he does not relate his mathematics to any higher system. An accident to the Soviet author must be similar to part failure for an American, but the American author is not talking about combat damage, he's modelling the budget constraints on peace-time electronic maintenance kits. There are many other examples of Indeytsev overstating Powell's conclusions. Possibly, the caveat at the bottom of the *Morskoy Sbornik* page, "From Materials in the Foreign Press", means that this author is floating some new ideas from his Naval Institute.

Turning to Indeytsev's article as a report on new thinking in survivability then, he begins with the "scientific technical revolution" radically changing the qualitative characteristics of ships of all types. Their "fighting capacity" is a function of many factors, one of which is survivability. The importance of survivability in the fighting capacity equation is increasing because of more powerful weaponry, increasing numbers of powerful armaments, and the proliferation of hazardous and flammable materials on ships.

The term, "expected or predicted survivability" is defined as:

> The predicted capacity of a ship to recover fighting capacity lost as a result of any combat action or accident.

"Expected survivability" is a function of:

- Effectiveness of enemy combat action
- Effectiveness of self defense
- Quality of the commanding officer's decision and the men's performance.

It is indirectly dependent on exploitational factors (operative-tactical factors, in other words).

The author analyzes each factor of expected survivability; the first is survivability, and effectiveness of enemy combat action. This factor is dependent on the "probability characteristics of the means of observation and defense and on those of the enemy's weapons system." The advent of new enemy combat means (especially the anti-ship missile) has increased their effectiveness. This requires new, passive defenses be built into the ship like localized armor plating, improving the mobility characteristics of the power plant, and improving personnel protection.

The next factor of expected survivability is the effectiveness of the ship's self defense. The author equates the Western concept "effectiveness of self-defense" to the Soviet term "combat stability". Combat stability is a function of the ship's "ability to withstand and counter blows by employing maneuver, ordnance, electronic equipment, reduction of physical fields, etc.."[8]

In contrast to combat stability, the author points out that the U.S. and NATO use the concept of "effectiveness of self defense". The factors in this measure are "passive, semi-active, and active defense". Passive defense is provided by the ship's technical, engineered survivability which, the author says, "as we all know" means:

- Unsinkability
- Security against fire and explosion
- Survivability of ordnance and technical equipment

Ship design is the structural manifestation of passive defense.

Semi-active defense includes a set of different factors and technical means:

- Secrecy of navigation
- Keeping physical fields within norms
- Avoiding enemy attack by maneuver
- Employing radiotechnical and hydroacoustic countermeasures

(Indeytsev defines maneuvering characteristics more specifically as the capacity of the ship to avoid ordnance.) Radiotechnical and hydroacoustic countermeasure effectiveness depend on the *quality* of electronic equipment (REV in the Soviet Military Dictionary). REV quality is in turn dependent on its ability to provide long range detection, determine enemy position accurately, classify targets correctly, and furnish timely data on targets to command and weapon systems. Semi active defense is a many faceted function of expected survivability.

The third and final element in Indeytsev's analysis of NATO's expected survivability is active defense. Active defense is defined as the rate of expending ammunition in shooting attackers down. The effectiveness of active defense, the authors say, is a function of personnel protection. Personnel protection, in turn, is a function of structural design plus:

[8]"Physical fields" is not specifically defined but is probably used to describe the aggregate of electro-magnetic, infrared, and acoustic fields around a warship.

Organizational and technical measures to prevent personnel injury from damaged nuclear power plants, from ionization radiation in nuclear explosions, from poisonous substances, from bacterial aerosols, and from toxics generated by fires.

Ultimately, active defense is a function of how rapidly suitably protected personnel can fire rounds at attackers.

Effective personnel performance is another factor in expected survivability. The information in this section has an American ring to it because of terms like, control fire and flooding, informing the captain of the nature and extent of the damage to the ship. This consonance could be caused by the translator trying to couch Soviet ideas in familiar terms for the audience, or it could be that the Soviets have arrived at the same conclusions about damage control as the U.S. and NATO. Whatever the reason, there are other shades of meaning in this article unlike American ideas on damage control.

The battle damage assessment phase of damage control is an area of difference between Soviet and American viewpoints on damage control. The author says, "strategy and tactics for damage control are worked out on the basis of evaluation of the ship's condition." The difference arises when the author describes the U.S. Navy's system for moving damage control reports from the petty officer on scene, through the damage control officer, and up to the commanding officer. This process sounds different the way Indeytsev puts it: "..it is accomplished by interrogating personnel and getting from them reports..." The verb, interrogate, has uncomfortable connotations for U.S. Navy personnel but fits into the Soviet concept of control. American sailors report. Soviet sailors interrogate.

Another of the factors of expected survivability are exploitational factors. "In the West, exploitational factors are technical, operational-tactical, and weather factors." Technical factors in survivability are:

- The time it takes to restore a power plant to operational condition from various initial conditions.
- The operational reliability of technical equipment and ordnance.
- Certain maneuvering characteristics: time to achieve full and maximum speed and time to achieve a full stop. (In various engine combinations)

Operational-tactical factors in survivability are those which have the most effect on ship control and damage control in battle or after an accident. These factors are:

- How long it takes to collect, process, analyze, and evaluate information about the situation.

- How long it takes to decide to execute any particular maneuver and to bring ordnance and damage control equipment to bear after the first damage.

Weather factors affect survivability in terms of seaworthiness. "Seaworthiness", the author says, is modelled "in the USA" with wind pressure and slamming immersion as the principle variables using wind speeds of 100 meters per second or hurricane force winds.

B. UNIT LEVEL OPERATIONAL-TACTICAL FACTORS

Operational-tactical factors are defined as those which describe the ship's use as an element of mixed forces of the fleet when it's called upon to solve one problem or the another. In other words, the characteristics a ship requires to function in a group of ships. Examples of operational-tactical factors are navigation accuracy, training and manning effectiveness, development of new tactics in the fleet, and naval tactical decision-making.

There are seven articles concerning operational-tactical factors of unit level effectiveness. The subjects range from navigating submarines under ice to evaluating risk in the decision-making process.

1. Evaluating Ship's Navigation Accuracy

Captain First Rank L. Krachkevich's 1973 article, "Evaluation of Navigation Accuracy Using a Dead Reckoning Factor", for *Morskoy Sbornik* describes how to account for stochastic variations in ship navigation. Navigation accuracy has the same meaning for the Soviets as for the U.S. Navy. Accurate navigation means knowing the error in positioning. Modern weapon systems require accurate navigation when weapons are fired at targets beyond the firing platform's own sensor range. In U.S. parlance, this is Over The Horizon Targeting (OTH-T).

Navigation accuracy depends on many factors, especially knowing the error present in dead reckoning.[9] In this article, the author shows how simple graphs and nomograms can help determine the "mean square error of the dead reckoning position, in miles". The information to calculate mean square dead reckoning error is readily available in several sources. The most obvious source for the Soviet Naval Officer is the *Soviet Watch Officer's Guide*, where on pages 160, 173, and 177 of the translation by NISC we can find the same information as Krachkevich presents in his article. In fact, the mathematics of the derivation for mean square deviation in d.r. position is the

[9] The word "dead" comes from "deductive", not from more nefarious sailor's superstitions about navigation.

same. Thus, he is not presenting anything new, just refreshing the memory of some ship's navigator who may have gotten sloppy in this positioning. The Soviet Navy had worldwide preeminence in long-range surface to surface missiles in 1973, but automated positioning data only came from two sources; DECCA and OMEGA. These systems have circular probability error on the order of two to five nautical miles, not good enough to fire *Styx* missiles 60 nautical miles and still hope to hit a ship. Thus, it's possible that this article was also written as a reminder for the fleets to review their dead reckoning procedures.

2. **Piloting Submarines Under Ice**

Captain First Rank Candidate of Naval Science Docent Zh. Sverbilov's 1978 article on "Special Features of Handling A Submarine When Navigating in Ice and Under Ice" is a less theoretical treatise than many of the other authors cited so far, but it does show how this operation relates to operational-tactical features of the unit level of effectiveness.

Navigating submarines through ice is important Sverbilov says, because it keeps combat training going on in fall and winter. (It is also crucial to safely navigate ballistic missile submarines through the ice). With these reasons in mind, let's follow his sequence of events to safely navigate under ice.

The first step is preparation for ice navigation. Divers should inspect the underwater hull paying particular attention to screws, stabilizers, vanes, shutters, torpedo tube chambers, kingston compartments, and discharge ports. Install a towing strop to the conning tower in the event that icebreaker towing is needed. In the final stages of material preparation, take on extra hull patching material in case of hull punctures.

The navigator's preparation involves developing a comprehensive knowledge of the transit route. Ice information should be plotted on both the track and situation chart. The coordinates of special interest are those of the ice edge, polynyas, and direction of the ice drift. The navigator should also plot the locations of icebreakers and rescue/salvage ships (a separate branch of the U.S.S.R. Navy).

Deck and seamanship department preparations include reviewing procedures for towing, following an icebreaker, and ice party actions in combating ice compression.

During the actual transit to the ice area, increase visual and "technical" observation. The commanding officer decides when to force his way through the ice

field and increases draft by fully or partly filling the main ballast tanks, protecting the screws, planes, and torpedo shutters. He will enter the ice field at a right angle to its edge with low momentum.

As the bow enters the ice, engage the engines ahead medium speed. Don't allow the submarine to be slowed to a stop. If slowdown begins, move backwards two full lengths and try to move forward again. If the submarine cannot move forward, make preparations to submerge.

Submerging a submarine in ice requires that the boat be dead in the water with all planes rigged in. If there is daylight, raise the periscope to observe ice thickness. The commanding officer selects depth based on analysis of three things: the ice situation, the tactical situation and mission, and on sonar and echo soundings above and ahead of the sub.

The echo sounder in the "ice fathometer" can measure the length of polynyas by applying Equation 4.1:

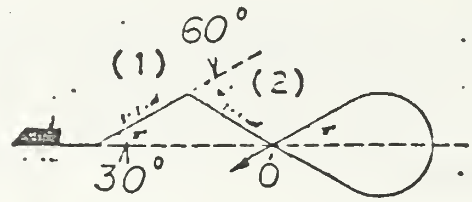
$$L = l \times V \qquad \text{(eqn 4.1)}$$

Where: L = polynya length in meters.
l = length of straight line trace on fathometer paper in millimeters.
V = Submarine speed in knots.

This equation works because the open water of the polynya appears as a straight line on the fathometer recording chart compared to the peaks and troughs of ice traces.

In addition to using the ice fathometer, Captain Sverbilov tells us that "heroes of the Soviet Union and submarine commanders", L. Zhil'tsov, Yu. Sysoyev, and others developed a method to determine the area of a patch of open water for surfacing. Once the ice fathometer indicated a polynya above them , they maneuvered the submarine in a figure eight as in Figure 4.4 at less than four knots. If the ice fathometer showed no ice during the entire maneuver, they surfaced at point O of Figure 4.4

Even though the submarine commander knows the size of the polynya, he surfaces very carefully, keeping all extensibles retracted and diving planes rigged in. The boat should vent bubbles from the middle group of main ballast tanks at successive



Legend: 1. S = 2 cables. 2. S = 4 cables. (1 cable = 1/10 nautical mile)

Figure 4.4 Determining the Area of a Polynya by Submarine.

stages of the ascent in order to disperse small pieces of floating ice. In conclusion, the author exhorts his readers to cooperate precisely between departments and get information to the commanding officer promptly in order to "guarantee navigational safety under ice".

3. **ASW Search Effectiveness**

While navigating submarines in ice showed an operational-tactical factor derived from practice, this next piece by Captain First Rank Candidate of Naval Sciences Docent A. Orlov called "Estimating the Effectiveness of a Directional Search Using a Stochastic Modelling Method" demonstrates that operational-tactical factors of unit effectiveness are also results of applied operations research and computer modelling.

This article presents the surface ASW unit commander with a decision aid for evaluating the probability of regaining sonar contact after it is lost. Although ideally the ASW ship wants to maintain continuous contact, in practice ships may gain and lose contact repeatedly or never even gain contact. In order to (re)establish contact, use a directional search. That is, head the ship outward on some radial from the original course, as Orlov explains:

> The essence of such a search is that the ship making the search lays a course equal to the bearing at which the initial contact was made, and steams on it for a

calculated period of time, closing to a range at which the target can be detected by other equipment.

For the commander, "it is essential to analyze the possibility of establishing contact" before committing to the search. The purpose of Orlov's article is to present the theory and results to aid the commanding officer in predicting the probability of regaining contact with either the same equipment or other detection equipment having "shorter range but better positional accuracy."

Before committing to the search, it is necessary to qualitatively analyze the possibility of establishing contact. The author presents the general problem flow in three steps:

- To calculate the effectiveness of the search:
- Calculate the probability of making contact
- Calculate steaming time and course if P(detection) is O.K.

The most difficult problem is determining the probability of (re)establishing contact. But aided by specialized computer programs utilizing an algorithm or previously calculated graphs, the decision can be validated. Orlov says there are three complicating variables in this problem. They are; uncertainty in the target data, when to initiate passive search, and determining the random values of target course, speed, and range.

Directional search effectiveness depends on three criteria; P(detection within time allotted) as the observer moves at a given speed and course equal to the bearing of initial detection, $M(t_s)$ the mathematical expectation of search time during the initial detection of the target at various relative bearings to the observer, and $t_s(max)$ search time during which there is maximal probability of reestablishing contact on a given relative bearing.

To determine these values, Orlov says, we have to account for the "entire complexity of the search process". The factors in this complex are the signal to noise ratio at the receiver, the range distribution laws of the detection means in a given ocean area, and the number of degrees of freedom in the error distribution laws.

Orlov used a Monte Carlo simulation on a computer. The variables input to the simulation are shown in Figure 4.5.

The model uses a random number selection of the variables listed above according to "given numerical characteristics and laws governing their distribution." In

t_s	Search time
q_{ho}	Relative bearing to target
$\oplus K_t$	Sector of possible target courses
$V_t(min) - V_t(max)$	Range of target speeds
R_{det}	Sonar detection range
R_{dev}	Mean deviation in sonar range
E_{df}	Mean direction finding errors in sonar

Figure 4.5 Variables for Search Effectiveness Model

order to run the model the following values are input: target location at the moment of initiating the search, target course and speed, and range and bearing of the initial detection. The output of the model is the range, r, between target and observer. The program compares r to R_{dev} at each moment in time for the particular detection means selected.

Running coordinates are then calculated for the observer during movement along a course equal to q_{ho}. Running coordinates for the target are also calculated during its motion on a course and speed selected by random number within the limits of $\oplus K_t$ Figures 4.6 and 4.7 show the results of the model runs. These figures are the principal nomograms for deciding whether or not to commit to a directional search.

Figures 4.6 and 4.7 are the "main criteria of the effectiveness of making a firm contact with a target during a directional search without a jump". (Jump means that the search ship increases speed when it loses contact.) Figure 4.6 shows the dependence of the probability of detecting an "energetic contact" over various search times and relative bearings to the target.

Orlov concludes from his models that the probability of reestablishing contact during a directional search both with and without a jump increases at first rapidly and later slowly, afterwards remaining constant at certain values characteristic for the initial target detection at a given q_{ho}. Thus after a certain time further search is senseless.

The effect of initial contact bearings, he concludes, is more favorable for regaining contact if there are large relative bearings off the bow since after turning

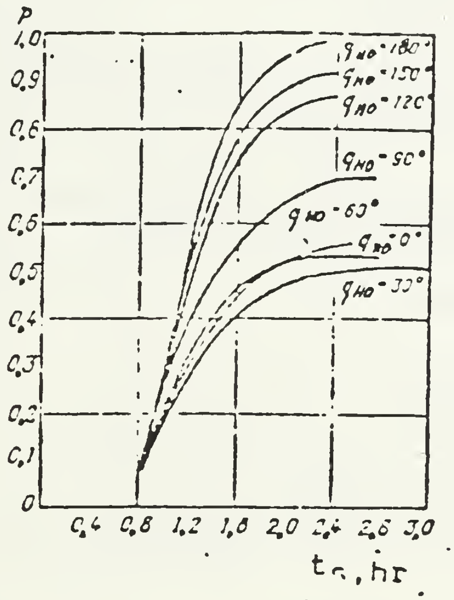


Figure 4.6 Probability of detection versus time spent searching

onto the contact's bearing, the distribution of probable target courses turns out to be towards the observer in a narrow sector.

Figure 4.7 shows that values for $M(t_s)$ differ insignificantly and have a decreasing trend as the relative bearing decreases. Thus, the effectiveness of a directional search depends mainly on the relationship between the operating range of the initial detection equipment and the second means of detection. The less these ranges differ, the higher the search effectiveness.

In a directional search without a jump, the sonar search effectiveness increases with increasing speed (contrast this, he notes, with barrier or area searches). In this case, the effect of the rate of change of the probability of regaining contact is greater than the effect of the range of the sonar.

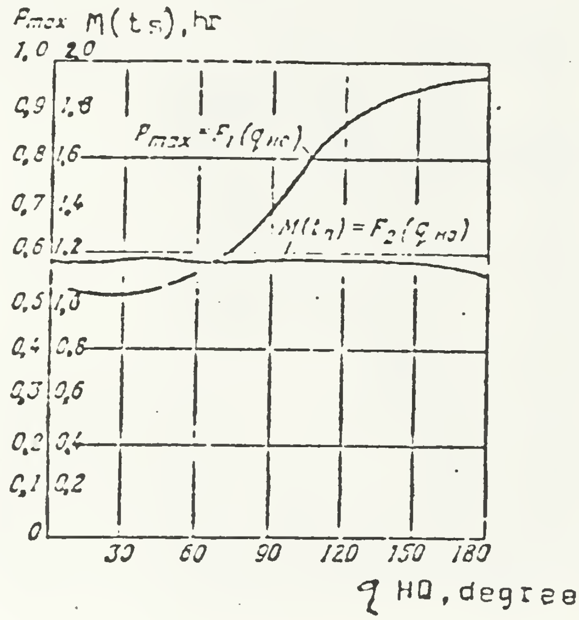


Figure 4.7 P(max) of regaining contact and the $M(t_s)$ needed to giveP(max)

4. **Unit Level Decision-Making**

In one of the most theoretical articles in this collection, Captain First Rank Candidate of Naval Science A. Blinov and Captain Second Rank-Engineer Candidate of Technical Science V. Yevgrafov expound at length on "Information and Decision-Making" in a 1975 article for *Morskoy Sbornik*. There is a great deal of practical advice on how commanding officers should set up their control points and what kind of information they should get from each point. The theory in the article is apparently designed to get the commander thinking about the problem of decision-making in the

terms of contemporary Soviet Military Science. This is certainly not to say that the articles in *Morskoy Sbornik* are the only exposure that a Soviet unit commander has had to decision-making theory, certainly they have seen it in their higher schooling or have read about it in sources like V.A.Abchuk's *Introduction to Decision-Making Theory*. The Soviet commander is probably familiar with a lot of the theoretical arguments in this article.

The article begins its arguments by stating that combat operations at sea are "complex situations" in which the "form, volume, and content of information" passed to the commander by subordinate "specialists" is of primary importance. The commander should always remember, they continue, that the opponent will try to inject disinformation and camouflage his action by all available means. The commander "can hardly plan on receiving an abundance of information in order to make a decision".

Information has two important characteristics; relevancy and timeliness. Relevancy means that information cannot be continuously consumed because a system can't absorb it. Information must be gathered into packets of importance. Timeliness of information is due to the proposals prepared by subordinates on the basis of current information.

The question is, how are these information control problems solved? The authors proceed to answer their rhetorical question.

Information control is solved in three ways;

- Increase the number of crew.
- Increase the "psycho-physiological' characteristics of specialists involved in collecting and processing information.
- Encourage the broad use of automated systems.

Of the three, increasing the use of automated systems offers the most promise for controlling information. The crew cannot be increased infinitely on a ship, similarly, man's potential mental and physical capacities are limited by aural and visual channels and memory capacity. But automated systems ensure that the "trained specialist's well organized work" guarantees proposals get rapidly prepared for the commander while "functional analysis" helps determine the structure and organization of the automated system's tasks.

What kind of system do the authors conceive for shipboard automated decision-making?

It is common knowledge that any ship is a complex multilevel man-machine system. It is necessary to view a ship control system as a hierarchical system which meets the principle of one-man command and represents the totality of personnel, the means and elements of control (command points, technical facilities, radioelectronic equipment, and weapons), and incoming and outgoing information. This system can include within itself several control circuits (subsystems). A control circuit is understood to mean the totality of control panels with communications lines, instruments, computer equipment, and personnel which carries out specific functions.

The information circulating in the system is classified as it comes into the control circuit in three ways.

- Command information (commands, orders, instructions from higher commanders).
- Coordination information (reports from supporting and cooperating forces).
- Internal state of the ship / external situation information.

The information coming out of a control circuit is classified differently. It is broken down as:

- Command information (commands, orders, instructions to subunits of the ship).
- Reports to higher commander.
- Information for supporting and cooperating forces.

What kind of information does the commander need? By using a "tactical situation model", Blinov and Yevgrafov remind us, the commander gets the information in a form he can use. The tactical situation model has the following four elements:

- Status of environment (area of operations and its defenses).
- Enemy characteristics and tactics.
- State of own ship and its tactics.
- Tactics and characteristics of supporting (cooperating) forces.

In the "control process" the commander reconstructs the tactical situation into a system of ratios between elements (e.g., enemy characteristics/own ship's).

To understand the tactical situation, "a study shows" the commander doesn't need discrete reports, but a "system of reports" describing changes in the tactical situation. The ship compiles a tactical inventory of information which lists characteristic parameters of each tactical situation element. Table 4 shows some representative parameters of the tactical situation model.

Following the pattern of information generalization, the commander's indicator scope of the control board instrument panel reflects the most generalized

TABLE 4
THE TACTICAL SITUATION MODEL

EXTERNAL ENVIRONMENT Air Water — surface, subsurface Ice Tropo-ionospheric Hydrometeorological
ENEMY CHARACTERISTICS A. Performance Characteristics of Forces Targeted for a Strike: Combatants Escorts Aircraft Helicopters etc. B. Observation and Communication Facilities: Radar, sonar,...etc.. C. Shipboard / Airborne Weapons. D. Fixed Means of Detection.
ENEMY TACTICS Diagrams of the cruising and battle formations of forces of ships and convoys. Their actual maneuvering. Ranges at which they can detect targets. Accuracy of direction finding.
OWN SHIP TACTICS Measures to guarantee exit from and entrance to the point of basing. Plans of types of defense when deploying to areas of combat operations. Modes of movement when overcoming opposing forces and facilities. Plans for maneuvering when the enemy is detected. Plans for maneuvering at the time of firing.
SUPPORT AND COOPERATING FORCES TACTICS Plans for organizing various types of defense when deploying to areas of combat operations. Plans for organizing escort for submarines. Plans for organizing cooperation while carrying out various combat missions.
OWN SHIP INTERNAL STATUS Engineering plant status. Condition of ship's spaces. Radiation and chemical observations. Watertight integrity. Firefighting / sprinkling systems status. Information about personnel and combat equipment survivability.

information. Other control points have their own indicator scopes, too. In order to increase the speed of information, the systems become automated. Thus ends, the authors assert, the first stage of the decision-making process; collection and analysis of information.

The second stage of the process is "the psychological act itself of the commander making a decision." Discussing this stage, the authors adopt the vocabulary of "management", calling the decision-making process "a study of management activity." What they mean by "management" becomes clear when the authors say analysis of the commander's management activity and of personnel in the "main control room and the control posts" reveal two fundamental types of activity: planning and executive.

Planning activity is selecting, comparing, checking logical conclusions and making a decision. Executive activity, in contrast, means reading information from dials or scopes, controlling elements of a panel by turning knobs or twisting dials. "Shipboard specialists" training has been most successfully analyzed in shipboard man-machine systems where the activity is primarily executive. Planning activity, they report, has been more difficult to quantify.

Decision-making for the commander can be represented as a feedback system. Information about the tactical situation guides the decision, the commander chooses tactical action based on information from his subordinates, and the commander then monitors the execution of tactical actions. The monitoring stage is where the commander accepts responsibility for his decision, nonetheless he "should , in general, provide for the compulsory active participation of subordinates in the process." This, simply stated, is the *principle of one-man control.*

One-man control has also been analyzed and Blinov and Yevgrafov categorize the actions of the commander in two areas. Table 5 shows the boundaries for the categories of one-man command.

These dual forms show that the commander's actions have a variable structure. "The most characteristic missions in management are complex groups of typical and untypical actions." Thus, analyzing the activity and applying the correct science to it (psychology, biotechnology, cybernetics, algorithm theory, mathematical logic, etc.) allows one to develop the correct algorithm. The digital computer can take over once the algorithm for the planning activity is discovered. "In principle, anything which does not contradict natural laws can be modelled." The authors don't give any report on the

TABLE 5

ACTION TYPOLOGY OF ONE-MAN COMMAND

ACTION'S FORM IN CARRYING OUT MANAGEMENT MISSIONS:	
I. Typical, standard actions (action guided by:)	
	Precise formulation of a specific goal established in a definite document (regulation, manual, handbook, combat order, directive, etc..)
II. Original, untypical actions (action guided by:) (Highly creative or independent actions)	
	Primarily characterized by ambiguous or indefinite mission. Ambiguous or absent procedures. Indefinite measures of effectiveness resulting in uncertain criteria for choosing action.

status of their modelling efforts, though, but finish with the safer thought, the ultimate task of modelling is "to improve the quality of control."

5. **Decision-Making and Risk**

In a 1976 *Morskoy Sbornik* article titled "Decision-Making and Risk", Professor and Doctor of Naval Science Captain First Rank V. A. Abchuk gives some more background to the study of decision-making. Of course, he wrote the textbook for Naval Officers in 1971 , *Introduction to Decision Making Theory*, and is probably writing this article for *Morskoy Sbornik* to refine some of the points made by Blinov and Yevgrafov (1975). There is a good possibility that many Soviet Naval Officers have had a course in decision making from Abchuk since he is a professor at the Grechko Naval Academy in Leningrad and postgraduate Naval education for all "command and engineer cadres of the Navy" is conducted in the same institution. (Scott and Scott 1984, p.379)

The purpose of this brief article is to remind ship commanders and flight crew commanders that decision-making in exacting situations is risky but that contrary to popular opinion:

> Today there is every basis for saying that a science capable of recommending to man a sequence of actions entailing risk does exist. It is the theory of decisions. It is based on cybernetics. It calls for broad use of electronic computer equipment and small-scale mechanization equipment.

The professor reminds his readers that they use operations research to validate decisions. Included in operations research are probability theory, games theory, mathematical programming, and others.

Problems with risk are characterized by uncertainty. This means insufficient information exists. There are two types of insufficient information: **first order** uncertainty is insufficient information about the opposing forces and resources of the opposing sides or its intentions, **second order** uncertainty concerns the "random nature of data about the situation and the expected results of battle--weather conditions, the hydrology of the sea, the possibilities of hitting the target." The reader should characterize the uncertainty first because first order uncertainty requires games theory methods while second order uncertainty needs statistical decision theory methods.

Abchuk gives an example of a first order uncertainty problem: your own submarine must penetrate the enemy base and reconnoiter. It can get into the base in one of two ways: in deep water or in shallow water.

- The enemy can organize a search in only one of the two places.
- Risk is defined as the probability of not completing the mission.

Decision required: which entry tactic minimizes risk?

This is a first order uncertainty problem since own ship does not know enemy intentions. The first step is establishing the effectiveness of each decision in view of the actions of the opposing sides. This is done by probability methods. The final results are shown in Table 6.

Abchuk continues the argument by noting that some commanders may "unfortunately" select only the most effective method each time when making decisions in the face of risk. But the enemy can also evaluate our actions and take countermeasures with "due consideration of our best version."

Assume, for example, that we use the shallow water approach and the enemy guesses our plan correctly and searches in the shallow water. The probability of success drops from 1.0 to 0.4. If we use the deep water approach and the enemy guesses correctly that we are coming in by deep water, then our probability of success goes down to 0.1. What should the commander do? Use the games theory approach because

TABLE 6

PROBABILITY OF SUBMARINE'S CONCEALED ENTRY INTO BASE

Movement of Submarine Into Base	Search by ASW Ships In Deep Sector	In Shallow Sector
In deep sector	0.1	1.0
In shallow sector	1.0	0.4

it recommends "using all possible tactical methods but with different periodicity of employment." Use the most successful methods more frequently than the less successful, but ultimately it "leaves the enemy ignorant of our intentions and forces him to prepare to repel any actions and dissipate his efforts."

Applying games theory to the submarine example then, Abchuk points out that the frequency to verify is how often to use the least successful approach. In this case, that means entering the base via deep water sectors. The commander picks his criterion; if the frequency for entering via deep water is 0.4, then that of shallow water is 0.6. In order to decide which route to take the commander can use his watch. At the moment of selection, if the second hand is within 4/10 of the minute scale, he chooses the shallow route. He goes for deep water if the second hand falls within 6/10 (36 seconds) of its range.

The author's second example concerns statistical theory and second order uncertainty. In this example, he shows how to estimate "tactical mission" risk for a group of torpedo boats. The boats have to attack a convoy but can choose whether to attack from seaward or shoreward of the convoy. Selecting the direction depends on the cloud cover, if it's sunny, the boats attack from seaward to come out of the glare. If it's cloudy, the boats attack from shore under the mask of land. Since weather conditions govern this process, this is a second order uncertainty problem requiring statistical methods. Abchuk makes an interesting comment here, sounding like he may have picked up some operational experience sometime.

> At first glance it seems that selecting a method of action based on nature and not on the enemy is much easier. However this is not so. In dealing with an opponent, it is not difficult to assume that he will always act in a manner most advantageous for himself. This as it were, removes a portion of the indefiniteness.

He begins the torpedo boat problem the same way as the submarine one, calculating a table of probabilities (Table 7) of successfully completing the mission.

TABLE 7

EFFECTIVENESS OF ATTACKING A CONVOY

Direction of Attack	Weather Conditions Cloudy	Sunny
From Seaward	0.3	0.4
From Shoreward	0.6	0.3

Assessing the risk in deciding from which direction to attack if the weather conditions are unknown: if the attack is from shore and we guess right about the weather being cloudy then the expected value of the attack is 0.6. If we guess wrong about the weather and it turns out cloudy during an attack from the sea, the expected value is only 0.3. The risk in choosing the wrong direction of attack in cloudy weather is 0.3 for seaward attack $(0.6 - 0.3)$ and zero for shoreward attack. In this way, Abchuk constructs a risk table for different situations. Table 8 shows the value of risk for choosing attacking directions in the face of second order uncertainty over weather. Table 8 shows that the least risk is in choosing attacks from the shore, regardless of the weather.

Abchuk closes this piece with the reminder that quantitative methods should not be used blindly.

> Actions under conditions of risk not only do not exclude, but on the contrary assume and demand that, along with quantitative methods, utmost use must be made of the know-how of the military leader and his intuition and that the multitude of other factors which do not now lend themselves to quantitative evaluation be considered. A wise combination of the theory of decisions and the commanding officer's proficiency permits establishing the "norm" of risk which guarantees victory.

TABLE 8

RISK OF CHOOSING THE WRONG ATTACKING DIRECTION

Direction of Attack	Weather Conditions Cloudy	Sunny
From seaward	0.3	0.0
From Shoreward	0.0	0.1

6. Estimating Critical Times of Operational-Tactical Factors

The purpose of Captain First Rank Candidate of Naval Science and Docent V. Tsybul'ko's 1981 *Morskoy Sbornik* article, "Methods of Estimating the Time of Performance of Assigned Jobs in a Critical Path Planning and Control System", is to remind mission planners how to calculate critical path times. These techniques are not exclusively used at the unit level but could easily apply at any level of the Soviet hierarchy. Tsybul'ko's opening lines show the strong continuity of the method throughout Soviet planning.

> Critical path planning and control techniques have been widely applied in the national economy and in military affairs . . . Military science and practice use chiefly time-based critical path models. They are employed to achieve many control objectives at all levels, from the commanding officers of combined forces to the commanders of ship battle departments or subunits.

This example of critical path planning shows up in the unit level chapter because Tsybul'ko's illustrations are of unit planning.

The key distinction between "national" and "military" affairs processes is the character of the time the planners work with. The national planner deals with deterministic time where, for example, he knows that the wheat must be harvested between 90 and 100 days after planting. Time is random, uncertain, or probabilistic in military affairs because enemy actions play a large and random role on mission planning. Probabilistic critical path models have not, according to the author, become the predominant form in military planning because of their "awkwardness and inadequate theoretical development". But if one such model were available, the time of processes in "combat and everyday activity of naval forces" could be quantified.

The author presents two models for probabilistic critical path planning and control. The primary model is used when time has only an upper limit, that is when there's no minimum time, the quicker it's done the better. The secondary model accounts for upper and lower time limits like those that occur when planning air strikes in which second waves must arrive between first and third waves.

The primary probabilistic model approaches the problem in stages:

- Stage 1: Determine time characteristics of each job.
- Stage 2: Construct critical path schedule and work out the sequence of jobs.
- Stage 3: Determine the parameters of the critical path: M-expected value of time to accomplish the job. σ-mean quadratic deviation in time to accomplish the job.

Equation 4.2 gives the mission planners a quantitative estimate of the probability of completing the task in less than time **t**. The value of **t** is "set by the commanding officer taking account of external factors like actions of the enemy and cooperating and supporting forces".

$$F(t) = P(T < t) = 0.5\{1 + \Phi((t - M)/\sigma)\} \qquad \text{(eqn 4.2)}$$

Where: T = random value of time performance of the task.

t = assigned time of performance, constant quantity.

Φ = Laplace function.

M = mathematical expectation of time of performance of the task.

In the simplest case, if the mission must be completed before an enemy action, "the given time is taken as equal to the enemy's time expenditure". As long as the enemy's time factor is known, equation 4.2 is appropriate.

If the enemy's limiting time expenditures are random quantities, equation 4.2 won't work. Consider for example, "the mission of combating forces with a limited duration of combat functioning (like guided missile submarine, aircraft carrier, and others)". Their combat functioning time, the author continues, is the time interval within which it completely prepares and launches all missiles or aircraft. The interval begins when the enemy receives the order to strike and ends when the last missile or aircraft is launched. The computation formula is similar to equation 4.2 but the constant quantities T, M, and σ are replaced by random variables $T\pi$, $M\pi$, and $\sigma\pi$. Equation 4.3 results.

$$P(T < T\pi) = 0.5\{1 + \Phi((M\pi - M)/\sigma_t)\} \quad \text{(eqn 4.3)}$$

Where:

T = random value of time interval for combat functioning.

$T\pi$ = r.v. of time for enemy combat functioning.

M = mathematical expectation of time to complete task.

$M\pi$ = math. expectation of enemy's time to complete task.

σ = mean quadratic deviation of own task functioning.

$\sigma\pi$ = mean quadratic deviation of enemy task functioning.

$\sigma_t = \sqrt{\{\sigma^2 + \sigma\pi^2\}}$

Equation 4.3 envisions that both sides begin operations at the same time. If one anticipates the enemy and makes some preparations beforehand like fueling aircraft, loading ammunition, etc., then equation 4.3 still applies by adjusting the critical path time, M, and σ for the remaining time.

Naval gunnery duels are classic examples of battling for the first salvo, gaining the time advantage. Although missile duels have replaced salvos lasting many hours, the principle is still the same: whoever gets off the first salvo increases their probability of success.

The secondary probabilistic model for critical path planning and control is characterized by upper and lower time limits. Or as Tsybul'ko says:

> In the process of combat and political activity by naval ships and units, there are missions (tasks) whose performance times have lower limits as well as missions which have both upper and lower time limits.

Lower limits alone mean $P(T > t)$. A good example is ceasing shore bombardment while friendly forces are landing. Upper limits are defined as before so combining the two functions gives equation 4.4

$$R(t) = P(T > t)$$
$$F(t) = P(T < t)$$

then:

$$F(t) + R(t) = 1 \quad \text{(eqn 4.4)}$$

and in the case of the lower time limit, the relationship derives from substituting equation 4.2 into equation 4.4, producing equation 4.5:

$$R(t) = P(T > t) = 0.5\{1 - \Phi((t - M)/\sigma)\} \qquad \text{(eqn 4.5)}$$

If the random quantity, $T\pi$, the time the target is functioning, is the limit, the calculation formula equation 4.6 looks like this:

$$P(T > T\pi) = 0.5\{1 - \Phi((M\pi - M)/\sigma_t)\} \qquad \text{(eqn 4.6)}$$

Equation 4.5 tells us the probability of performing the mission later than the assigned time. Equation 4.6 gives the probability of accomplishing our mission later than the enemy's.

Looking at missions with combined upper and lower limits is the next step. Tsybul'ko explains what kinds of problems have these bounds:

> Typical two-way limits are the beginning and end of the daylight hours and hours of darkness, the beginning and end of the rising and falling tides, and the rising and setting of the sun or moon.

He goes through the same steps as before to derive the models.

For constant time intervals t_1 and t_2:

$$P(t_1 < T < t_2) = 0.5\{\Phi((t_2 - M)/\sigma) - \Phi((t_1 - M)/\sigma)\} \qquad \text{(eqn 4.7)}$$

where T is the value of the random variable of the assigned time to complete the mission. Normal distribution tables are used to calculate the probability that T is between t_1 and t_2.

For random time intervals, T_1 and T_2, the distribution functions for the random quantities τ_1 and τ_2 are found:

$$\tau_1 = T - T_1$$
$$\tau_2 = T - T_2$$

After transformation, the author presents equation 4.8 for calculating the probability that random quantity T will lie between T_1 and T_2.

$$P(T_1 < T < T_2) = 0.5\{\Phi((M_2 - M)/\sigma_{t2}) - \Phi((M_1 - M)/\sigma_{t1}\} \qquad \text{(eqn 4.8)}$$

where M_1, M_2, σ_1, and σ_2 are mathematical expectations and mean quadratic deviations for random quantities T_1 and T_2. $\sigma_{t2} = \sqrt{(\sigma^2 + \sigma_2^2)}$, σ_{t1} is similarly calculated.

In concluding this article, Tsybul'ko makes a final sales pitch for these methods by striking the unit commander's or the chief of staff's main concern in the planning process; evaluating the feasibility of the plan.

> They enable us, for one, to broaden the range of tasks (missions) performed using probabilistic models for critical path planning and control and ,for two, to have a higher degree of precision in envisioning a random quantity such as the length of time it will take the enemy to carry out particular operations. In other words, it will raise the level of substantiation for an evaluation of the situation when working out the plan.

7. The Research Approach to Unit Training

This 1983 article by Captain First Rank V. Yevgorov and Captain Second Rank Candidate of Military Science F. Chausov[10] titled "The Research Approach to Combat Training", emphasizes the practical aspects of data collection at sea. Almost all of the preceding articles have implied the existence of a vast database of one form or another. This article tells all officers how providing their comrades ashore in the research institutes with data from their combat training will ultimately give them new tactics to use against the enemy.

The authors encourage all ship's officers to take "the research attitude at sea", especially in combat training. They cite examples from Soviet submarine combat in 1941 to show the role that operations research ashore played in developing new anti-convoy tactics. One tactic, the delayed torpedo spread, is credited with convoy sinkings in the Northern Fleet waters at Kongs Fjord and Lakse Fjord by submarine D-3 on December 5, 1941. The technique is for one sub to fire multiple torpedoes with time intervals between them (e.g., four torpedoes at ten second intervals). This new firing pattern evolved directly out of combat debriefing of submarine skippers in the winter of 1941-42. From 1942 on, the delayed torpedo spread was the rule, increasing effectiveness, the authors maintain, from thirty to fifty percent. This also enabled the

[10]This is his second article in this collection. The first article is called "The Central Link in an ASW Team"

subs to increase their firing range from 4-8 cables to 8-12 cables.[11] The main drawback of the multiple torpedo attack was that the submarine had to remain on the same firing course for the entire firing sequence, making it vulnerable to detection. The "multiple-spread" salvo emerged from research in 1943. Effectiveness increased seventy percent. The overall lesson that emerged: one ship should share its discoveries with the collective of ships.

> This kind of attentive, watchful attitude toward progressive experience and the research approach to its application is typical of our Navy.

Combat training is the most important area for displaying the research attitude today, the authors say. Some researchers go to sea to analyze combat training or to work out details of theoretical studies they've made during their advanced education. These projects may vary in their scope,"but it is important to derive from every one some benefit for ship, force and fleet." Therefore, they advise, "it should be mandatory to set some purely research objectives, in addition to those relating to the performance of tactical, firing and other missions".

Staff officer-specialists are the officers most often involved in gathering data at sea. After a project is identified, a research group is formed to organize the data collection, determine the ships to collect the data, and develop the "documents on the form and method of data collection...and the procedure for preparing and presenting the results."

This research approach means a lot of work and preparation for the ship. Apparently, judging from the tone of the article, the research approach hasn't been popular with the ship's officers. The authors say that the benefits of research far exceed the extra time it takes to prepare for it, but that the benefits have not been explained to the fleet officers. "At the level of the single ship, it is thus far slow in becoming established". The mark of the research approach is progressive, rational improvement in the quality of the elements of "mission performance". The final and most important reason for adopting the research approach, the authors remind their readers; the Party wants it implemented.

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[11]One cable equals one tenth of a nautical mile.

To be an innovator in one's own field is one mark of a modern working style. At the 26th CPSU Congress this quality was ranked right alongside competence, discipline, initiative and serious diligence.

V. FORCE LEVEL MEASURES OF EFFECTIVENESS.

One step up the hierarchy of Soviet organization from the unit is the force. At this stage the combat unit is a group of ships, submarines, aircraft, or combinations of them. The effectiveness of the force is now a function of aggregate firepower, ASW search equipment, or some other index of effectiveness. Khudyakov makes this observation on estimating the effectiveness of ships:

> Combat operations in the sea are characterized by exceptional variety, in particular, with respect to nature and type of operations (control of the groupings of surface ships, operations against shore targets, submarine chasing operations, and landing operations); with respect to the forces participating in these operations (joint operations of submarines, surface ships, and aviation in various combinations) and the combat means used (missiles, torpedoes, mines, bombs, artillery shells and so on). Khudyakov (1981, p.74)

And Shul'man (1976) says force effectiveness is determined mainly before an operation begins. Missions are narrowly defined courses of operational action with definite measures of effectiveness. The staff formulates missions based on the commander in chief's goals for the operation and relays them to subordinate forces.

> properly worded operational missions with the given degree of effectiveness of their accomplishment allow us to determine the individual missions and build the operational-tactical model of combat operations. And only after that, in considering the numerical strength of the opposing enemy groupings, can we find the requisite detailing of forces to attain the goal.

For example, Shul'man provides criteria for evaluating the success of a mission:

- Destruction: 80-90% of enemy force sunk or inoperable.
- Defeat: up to 70% sunk or inoperable.
- Doing damage: 50% sunk or inoperable.
- Substantial weakening: 30% sunk or inoperable.
- Weakening: 10-15% sunk or inoperalbe.

The articles selected for this chapter from *Morskoy Sbornik*, all deal with some aspect of force level effectiveness. Before proceeding to the details, their subjects are summarized below.

In a series of three articles in *Morskoy Sbornik*, between 1977 and 1979, two principle authors debate the role of mathematical support to decision-making. One side maintains that given the correct mathematical model and computer program, a commander can simulate all aspects of combat decisions before the events and thus drastically improve his success. The other side says not quite, we don't have the computer languages to do that much simulation of the commander's thought process yet and there are just too many factors for the commander to consider to let a computer take over. There is a "functional independence of control processes from technological support."(Babyy 1978)

Another planning problem for staffs to work out is organizing opposed force tactical exercises at sea. Kuvaldin (1984) canvasses the elements of decision-making that optimize combat training for all echelons and emphasizes the top-down planning and execution style of Soviet force control.

Planning the tactical movement of forces in combat operations at sea is another job of staffs. Makeyev (1980) emphasizes the importance of keeping track of enemy ballistic missile submarines and reviews the methods for directing anti-SSBN forces.

The 'obvious' utility of combined aircraft carrier and airborne warning and control system (AWACS) groups for first-strike is one reason the Soviets view the aircraft carrier as a first-strike weapon. Aristov (1985) goes into detail on the U.S. system for over the horizon targeting (OTH-T), explaining why the U.S.'s combined assets are named "reconnaissance-strike systems".

Equipment alone does not count for the force effectiveness.

> The battle readiness of the control system, which includes control stations, staffs, and communications, automation, and suitable coverage equipment, is a component and a very important part of the battle effectiveness of naval forces. (Lebed'ko 1984)

Lebed'ko takes up the subject of increasing the effectiveness of staff officers (also known as staff officers) through training.

A. THE DEBATE OVER MATHEMATICAL SUPPORT TO FORCE CONTROL

In his 1977 article, Captain First Rank N. Makhrov reports enthusiastically on the work in combining operations research methods with computers to improve Naval force control.

The first step he takes, though, is to place naval force control in the proper context (Figure 5.1). Within the rubric of naval force control, the field of mathematical support is in flux; terminology isn't fixed. But mathematical support in this context means applying operations research and computers to the planning activity of staffs.

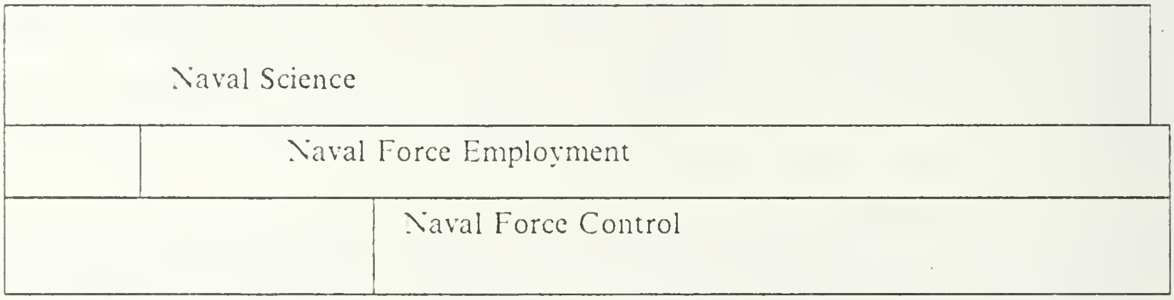

Figure 5.1 The Position of Naval Force Control in Naval Science

Specifically, there are two concepts which are effectiveness indices of decision preparation, "quality of decision preparation" and "effectiveness of force action". He defines "quality of decision preparation" as the degree to which it corresponds to the situation at hand. The "effectiveness of force action" is the "measure of achievement of the goal".

These two concepts are related this way:

> The higher the **quality** of the decision preparation, the more **effectively** a combat mission can be carried out, with all else being equal. (Emphasis added)

In Naval force control, the quality of decision preparation should reflect "the probability of performance of a combat mission or the mathematical expectation of damage infliction". There are various methods and techniques used in operations research to raise the quality of decision-making and "it is impossible to apply them effectively without computer technology and automated control systems".

"Quantitative methods and automated control systems are a dialectical unity". In other words, quantitative methods and automated control systems are components of the same dialectic, they have to be considered as inseparable parts of the force control framework.

The author maintains that with advances in operations research and computer technology it's now possible to raise the quality of decision-making which leads

naturally to improvements in force control. "A new, previously unforseen opportunity" arises for commanding officers to model "all stages" of upcoming combat missions and "reveal the patterns of upcoming operations". The big payoff for the commander is that now he can decide optimally from among the "multitude of possible ones, not from among the several standard variations, as is sometimes done".

Makhrov admits there are limitations to what the models can do. Decision-making is still in the commander's hands. "Operations research specialists" prepare "proposals for decision-making" only. The commander must fuse these proposals with "...experience, common sense, intuition, and other factors which stem from the status of friendly and enemy forces and the condition of a situation."

Other limitations are inherent to the simulations. "Mathematical models consider most fully only the chief factors of a process". Effectiveness assessments are based on mean probable values thus describing a **trend** rather than **predicting** a single event. Operations research cannot determine the time and form of various random events which may influence the outcome of combat.

Given the role of mathematical support, Makhrov continues, how should it be organized? First, centralize its role in the staff specialists who run the simulations. Don't let the work become fragmented. Concentrate the effort on systematic solutions to the problems at hand. Second, increase the efficiency of models by preparing "block models" ahead of time. These blocks are the "building material" for shaping the necessary model as quickly as possible. Using "block models" allows one to simulate the process of force control for a specific situation, rather than for standard situations. Third, use a systems approach, apply all methods available "...operations research, the qualitative method, and full-scale simulation, as well as experience, intuition, etc."

Throughout all of this, the commander-in-chief's role is unchanged:

> He assigns the mission for research (or for working up proposals); he selects or confirms the effectiveness index; he supervises the progress of the work; and he makes and implements the decision.

The counter argument to Makhrov's vision of mathematical support to force control came from Vice Admiral Candidate of Naval Science V. Babyy, although the reply was hardly rapid. Makhrov's article appeared in issue number one of 1977 while Babyy's reply was printed in issue number three of 1978.

Vice Admiral Babyy, backed up by two Doctors of Technical Science, who are also Captains First Rank, replies that mathematical support to force control is a new category of naval strategy. In this sense, they show what they mean by "mathematical support" is algorithm development for automatic control systems but primarily weapon control systems. Its place in force control in the staff's work is minor. Examples of how the support works are in feedback of processes taking place during combat and the functional independence of the control process from technological support.

Feedback of processes taking place during combat. The commander-in-chief decides what the operation plan will be (his basic objective). The staff takes the basic elements of the plan (direction of main strike, composition of the forces, procedures for cooperation) and works out alternative proposals and makes detailed calculations. The initial operation plan and the staff's proposals are "integrated with the computer calculations". This process is accelerated with continuously updated information "being produced with the help of mathematical support, the symbolic language of which feeds back the actual actions of the two opposing sides and the relevant conditions and circumstances."

Functional independence of control processes from technological support. Note that the terms used in "mathematical support of control" have not included "automatic control system", "computer system", or "electronic computer". Mathematical support of control is separate and existed when the support was in the form of torpedo firing tables. Certainly, the introduction of the computer was a powerful impetus to develop mathematical support of control processes but the concept should not be linked with the technology of the control system. Instead, the term should be linked to the control process. Because of this confusion between technology and process the authors complain, attracting mathematicallly qualified staff officers has been difficult.

This dichotomy between mathematical support and technology shows up in research and development of automatic control systems. The glamorous job is hardware development. The seemingly insignificant but actual "soul" of an automatic control system is its mathematical support, especially the specialized programming language. Underestimating the role of mathematical support in automatic control systems has led to loss of effectiveness in system operation because of ineffective mathematical language development.

"Underestimating the importance of mathematical support of control paralyzes the technology of automatic control systems, sharply reduces it efficiency, and prevents

improvement in the quality of control". In Vice Admiral Babyy's mind then, mathematical support to Naval force control means developing algorithms and programming languages for automatic control systems. Staffs may use these automatic control systems but don't rely on them for planning.

The third and final article in this series appeared in issue number 4, 1979. Captain First Rank Candidate of Naval Sciences Docent Makhrov (his 1977 header didn't credit him as Docent) enlists another Captain First Rank and Docent to assist him in this debate.

Makhrov replies to the Babyy article and expands the definition to contain his earlier operations research centered concept with the development of programming languages and algorithms. In essence, he applied dialectical analysis to this question, synthesizing two antithetical concepts into a new larger one. The result of this synthesis is that mathematical support to force control has "two aspects".

> First of all, it is a process of comprehensive quantitative substantiation of the commanding officer's decision in exercising force control at all stages of performing the assigned mission. Secondly, it is the aggregate of mathematical models, algorithms, and programs designed for performing calculations in the interests of force control, as well as the complex of reference tables, nomograms, and other forms for displaying the results of calculations accomplished and displayed ahead of time.

Dialectical thought notwithstanding, Makhrov's bow to Babyy's idea is cursory. He soon returns to his own more familiar area of operations research and automated force control.

The key to contrast the two sides is where to place mathematical support to force control in the theoretical hierarchy. Babyy puts it in Naval Strategic Employment, Makhrov places it in Naval Art. Using the Scott's (1984) breakdown in Figure 5.2, we see that there is a difference in emphasis depending on where the concept lies.

Naval Art includes the theory and practice of combat and armed naval conflict as a whole. Naval Strategic Employment includes categories of

- Strategic use of force.
- Force control
- Support for combat operations.(Strategic intelligence, rear support)
- Training and readiness.[12]

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[12]Scott (1984, pp.74-75) uses the term Naval Strategy in lieu of Naval Strategic Employment. The Russian word is *strategiya* in this category of military terminology. Soviet Naval Strategy, in the sense Americans use it, is nonexistent in official military

Military Doctrine
↓
Naval Science → part of a unified military strategy.
↓
Naval Art → Theory and Practice.

Naval Strategic Employment → Force Control, etc..
Naval Operational Art
Naval Tactics

Figure 5.2 The Embedded Concepts in Naval Art.

The argument over where mathematical support to force control belongs is the basis for disagreement between the two camps. Until this theoretical argument is settled and mathematical support to force control comes to roost as a topic of Naval Art or of Naval Strategy, the 'proper' use of operations research and computer programming on naval staffs will be a problem.

The real result of the dialectical process is incomplete since the two sides of the argument have not reached a unified understanding of the concept. Certainly, there could be a number of factors preventing a synthesis of views, but this may also represent a higher level argument over a doctrinal aspect of the "scientific and technological revolution" before the computer development takes place. As Scott and Scott note in their section on Soviet Military Doctrine:

> In the United States, as a general rule, weapon systems are developed first, and later, if production funds are approved, rationalization is given for their development into operational units. A different pattern is followed in the Soviet Union. If the state of art permits a radically new weapon system, a doctrinal modification first may take place, with production and deployment of the new weapon at a much later date. (Scott and Scott 1984, p.68)

In the case of mathematical support to decision-making, the "radically new weapon system" is the computer aided staff officer.

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doctrine. Strategy is unified between all branches of the military services.

B. COMBAT TRAINING DURING OPPOSED FORCE TACTICAL EXERCISES

Captain First Rank O. Kuvaldin advocates opposed force tactical exercises in his 1984 *Morskoy Sbornik* article, "Combat Exercises During Opposed Forces Tactical Exercises" for increasing the combat effectiveness of ships and staffs. He notes how exercises in which one group opposes the other are generally agreed to be:

> The most effective and most objective form for checking readiness to conduct combat actions, the commanding officers' tactical proficiency, and their ability to use the tactical capabilities of shipboard weapons and equipment.

For individual ships the outcome of duels between equal forces depends on "the preparation of ships and their crews and on a proper situation estimate", that is the outcome depends on training and tactical intelligence.

The indicators of a commanding officer's maturity, his tactical acumen, are:

- Attaining surprise through concealment.
- Deception of the enemy.
- Anticipation of enemy intentions and tactical pressure.
- Competent use of the techniques and means of opposition.
- Success in hitting the target.

The indicators of a force commander's skill are as much in planning the exercise as in executing it. The staff officers prepare the exercise plans for both sides. These plans include:

- Initial conditions for performing the exercise.
- The formation (if several ships are supporting).
- The formations' "maneuver elements".
- Assigning the mission to both sides.

During the exercise, staff officers umpire on board and on return to base, conduct post exercise analysis on charts.

The staffs should also be tested during opposed force exercises. They should only assign the enemy his mission in the most general way to allow him the most flexibility in trying to achieve their objective.

The same kind of opposing mission orders should be prepared by higher headquarters to keep the staffs in the game . The commanders of opposing sides will then be judged on how well they understood the mission and on how well they carry it out. "To reduce the documentation to be drawn up the exercise plans can be compiled

as standard plans" and "assignments can be sent to the participating forces by message using a formatted text".

The author observes in conclusion:

> Only an analysis of opposition permits an objective assessment of the level of battle readiness, practical mastery of the tactics and methods by which a ship or group of ships conduct an action or attack, and tactical employment of equipment and weapons.

C. FORCE LEVEL SUBMARINE TRACKING

One of the major problems facing the Soviet General Staff today is defending the homeland from submarine launched ballistic missiles (SLBM's). The 1980 *Morskoy Sbornik* article by Captain First Rank Candidate of Naval Sciences B. Makeyev titled, "Tracking and Guidance in Combat Operations at Sea", delineates the Naval Strategic and Operational Art of tracking submarines and guiding ASW forces to destroy them. This material is important for staff officers to know and (presumably) apply in ASW.

Most of the ideas in this piece are attributed to "military specialists in the capitalist countries" or reports from the foreign press. A number of paragraphs intermingling with those of the Western press reveal the Soviet perspective on the two main concepts in ASW; **tracking** and **guidance**.

1. Tracking Nuclear Weapon Equipped Ships and Submarines

The principal objects of tracking are nuclear capable platforms. Tracking is the whole category of searching for, discovering, and maintaining prolonged contact with the enemy. Tracking forces are those with appropriate equipment for reconnaissance, observation, communication with force command, and with "weapons ready for immediate use". One of these trackers, the "tattletale" (as U.S. Navy calls the shadow behind their carriers) may also use their tracking data to "guide other forces to the enemy and provide target indication if they do not have vigorous contact with the enemy".

Tracking can also be accomplished by:

- Multipurpose submarines.
- Airplanes
- Helicopters
- Stationary sonar systems.

Stationary systems have drawbacks, however, they can't be deployed over the entire ocean area that might contain SSBN's, they have relatively low locating precision, they have "low battle stability in comparison with mobile forces" (that is, they are easy to destroy).

There are three types of tracking:

- Concealed or open.
- Continuous or episodic.
- Conducted by single ship or group of ship.

Tracking is concealed when the enemy doesn't attempt to evade the tracking forces by hiding its actions. Tracking is open when ships and aircraft use active acoustics to track subs or when surface ships are tracked by a force capable of "repelling or weakening a surprise attack" by the ships its tracking.

Tracking is usually a "discrete process of maintaining contact and restoring it when lost". The effectiveness of tracking equals the amount of time the tracker watches the target. A tracking period is counted as continuous if the target does not leave the tracker's weapons radius. If the target's fire control solution becomes outdated then tracking is discrete, but increasing the number of times that tracking is regained can increase tracking's effectiveness.

The staff should consider a number of factors when placing tracking units:

- *Tracking position*-relative bearing, distance, and depth.
- *Weapons range*-the relative range difference.
- *Communications with command*-the tracker's communication range.
- *Speed*-the relative speeds of the tracker and target.
- *Operating range of observation equipment and concealment of their use.*

In general, the effectiveness of tracking is improved if it is done by a group of forces.There are categories of groups of forces to consider also. Groups of similar types-usually track important individual objects (SSBN's, carriers). They should operate in different sectors relative to the target to avoid mutual interference. Mixed groups of forces are used to track battle formations.

Tracking requirements are also influenced by the political-military climate. Single ships are usually adequate for peacetime but as tensions build the trackers form into groups. As the situation worsens, the tracking groups are transformed into strike groups.

2. Guidance: Vectoring Forces to Enemy Locations

In any kind of guidance there must be "reliable communications between the controlling command posts and the forces being guided". The author says that he is only considering the "basic principles of guiding submarines and aircraft".

Submarine guiding is based on a lot of World War II analysis of German U-Boat tactics. Historically the German guidance methods evolved into the "wolfpack" while the Soviets developed the "hanging screen". The wolfpack consisted of ten to twelve submarines vectored toward a convoy by reconnaissance planes. The first sub to find the convoy would not attack but reported the targets' position to the command post and remained on scene undetected. The command directed the remaining subs into position. The wolfpack would then simultaneously attack the convoy.

The Soviet's version of submarine guidance, the "hanging screen", had its beginnings in 1944. Submarine waiting positions were cut into regions "hanging" over sectors of coastal sea lanes twenty five to thirty miles out from them. Aerial reconnaissance would either radio the subs directly or via a command post to vector them out to the convoy for attack.

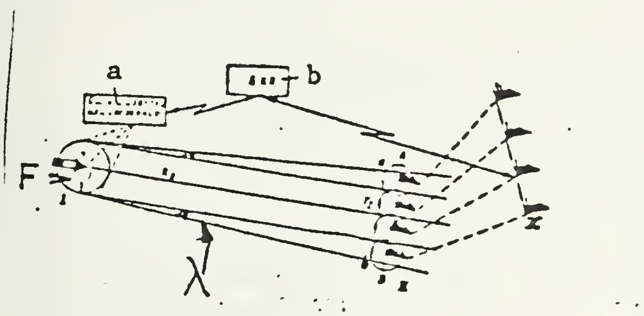
Contemporary conditions make longer range underwater operations possible, the author continues, because of long-range missiles, high endurance speeds, long underwater stays, and powerful "super long wave transmitters". Guidance methods for "all leading navies" are broken down into three types:

- A) Guidance to probable zone of enemy movement.
- B) Guidance to a firing area.
- C) Guidance to a zone for observation of the enemy.

Staffs should apply these methods to the following submarine types:

- Method A for guiding SSN's.
- Method B for SSBN's.
- Method C for the sub doing the tracking.

What are the procedures for the three methods? The author provides illustrations reproduced as Figures 5.3 and 5.4. Figure 5.3 shows how the SSN's should ideally intercept the convoy's position of intended movement (Method A). Although the staff has to account for a number of positional uncertainties and for the convoy's own sonar detection ranges, with aerial surveillance and external command posts, the procedure is straightforward.



Key: a. Reconnaissance or Tracking Forces;
b. Lateral Command Post.

Guidance of Submarines to Probable Zone of Movement of Ships (Schematic Diagram):

I. Region of probable position of ships at moment of detection;
II. Initial position of submarine;
III. Line of detection of enemy ships by submarine equipment.

Where:

F = position error in determining enemy's position.

λ = error in determining convoy's course.

Line AB = line of submarines on position to intercept.

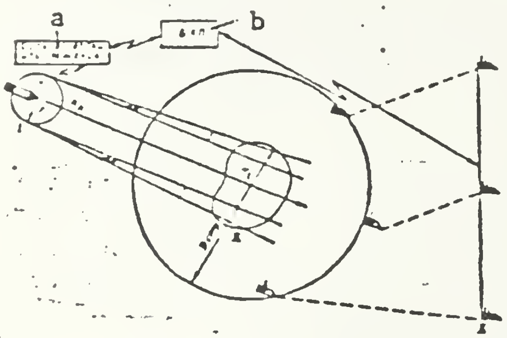
Line ab = line of effective sonar detection.

Figure 5.3 Guiding Submarines to Intercept a Convoy

Figure 5.4 shows a coordinated attack position for SSBN's firing on a central area containing the enemy forces (Method B). The essential distance is the maximum firing range of the weapon, each submarine must be within firing range at the given time to cover the area of fire.

The submarines have to be moved to the area of fire on time and in a way that ensures each submarine's weapon can cover the entire enemy's probable position and yet avoid interfering with each other's targeting.

In method C guidance, submarines with long-range sonars are moved to an area outside the radius of ASW forces but within their long-range detection capability. The zone boundaries are calculated as follows:



Key: a. Reconnaissance or Tracking Forces;
b. Lateral Command Post.

Guidance of Submarines to the Area of Fire (Schematic Diagram):

I. Area of probable position of enemy ships at moment of detection;
II. Initial position of submarine;
III. Area of probable position of enemy at moment of fire.

Figure 5.4 Guiding SSBN's to the Area of Fire

$$R_1 = F + R_{asw} + \underline{V}_e(T_2 - T_1) \qquad \text{(eqn 5.1)}$$

$$R_2 = d_o - R_1 \qquad \text{(eqn 5.2)}$$

Where:

R_{asw} = enemy ASW sensor range.

F = enemy position uncertainty.

$\underline{V}_e$ = enemy velocity

T_2, T_1 = observation times.

d_o = own force sonar detection range.

The area between circles of radii R_1 and R_2 will be the desired zone to move the tracking submarines into.

The process or system for guidance begins at the shore command station. Data from reconnaissance or tracking forces determine the probable movement of enemy forces. A "battle formation" is outlined to ensure effective use of weapons against the target. The command post transmits the following to the submarines:

- Coordinates of the center of the target's postion at an advanced time.
- The battle formation.
- The time to move to station and the time to be on station.

The shore command post updates the submarine with new enemy positions until the submarines arrive on station in the best possible position.

Aircraft guidance is accomplished with radio electronic means and reference points on the ground. The author distinguishes between guidance for strike aircraft or intercepters. The strike aircraft attack ground or maritime targets. In a way their guidance is very similar to submarine's. Reconnaissance planes report enemy location and velocity vectors to the command post which guides the strike aircraft to the future position of the target.

Guiding intercepter aircraft requires much more detailed control. "Preliminary guidance" brings them to the vicinity of the target. "Immediate guidance" puts them in position for the attack. Guidance continues until the on-board radar locks on or the target is in view. The rest of the battle is left to the pilot.

The author closes his piece with an interesting idea:

> Thus, tracking and guidance are key elements of modern sea warfare. With appropriate organization of the use of forces, they can significantly lessen the impact of the factor of surprise and create favorable conditions for delivering a strike.

D. RECONNAISSANCE-STRIKE SYSTEMS AS FIRST STRIKE WEAPONS

The authors of this 1985 article in *Morskoy Sbornik*, Captains First Rank A. Aristov and B. Rodionov call the U.S and NATO combination of aircraft carrier and AWACS a "reconnaissance-strike system."[13] But there is more to the force level

[13]This same term "reconnaissance-strike system" is used by Soviet arms control negotiators to label combined U.S. systems (NAVSTAR Global Positioning System & Trident, AWACS and Pershing II, etc.) which they assert could perform strategic targeting and strike. Using the term in the Naval Digest may be a way to show the authors understand doctrinal arguments and have found some sea-going analogues to add to the list. Source on meaning of "reconnaissance-strike": Judith Grange, SAIC,

thinking of the NATO countries than just the combination of these platforms. The real problem is the West's "doctrine of quality" which is springing from the "second scientific revolution". The motive force behind this revolution is microelectronics. The authors admit that this technology is being used "more and more widely in the West".

The "doctrine of quality" is a large scale program to achieve superiority in weapons systems over the Warsaw Pact. This doctrine concentrates on development of high precision, all weather weapons with point target P_k's increasing to eighty percent. Weapons this accurate and destructive rival the power of tactical nuclear weapons.

In order to achieve theater victory, the Soviet authors say the "Pentagon" must be able to launch a first strike immediately on detecting an enemy in range with enough strength to guarantee destruction. The problem is, weapon ranges today (400-500km) outdistance the guidance of their launch platforms. The solution, as American specialists are reported to see it, is to combine all combat and support assets into "dedicated, unified reconnaissance-strike systems" that will constitute a new weapons system from a "technical and military" perspective. The new system isn't just a combination of search, tracking, and guidance assets but a

> completely integrated, highly automated system designed for launching a powerful strike simultaneously against several targets according to the principle "quickly-detected-instantaneously and reliably killed."

The authors see a historical pattern to the development of this concept in the West. First came the use of Hawkeye (E-2C) aircraft in Vietnam as airborne command posts. Then the Israelis used Hawkeyes, F-15's, and Remotely Piloted Vehicles (RPV's) in Lebanon to direct strikes against otherwise concealed targets. The Boeing E-3A AWACS is another air reconnaissance platform which the U.S. hopes to use to support deployment of naval forces from U.S bases and operations in "barrier zones" like Greenland-Iceland-Great Britain, Japan-Aleutian Islands, and also in limited areas like the Mediterranean and Persian Gulf.

In other developments of reconnaissance-strike systems, the AEGIS system is an important part of the point and zone defense of "combatants and combat formations". ASW reconnaissance-strike systems are also in development, according to the authors, since there is a lot of work in long-range detection systems, automated acoustic collection and analysis systems, and in real-time data transmission to strike forces.

Lecture at Naval Postgraduate School, Monterey, California, 7 Nov. 1986.

The authors note that U.S. reconnaissance-strike control centers are the brains of the system, evolving into airborne command posts. The maneuverability of the airborne command post increases the capability for retargeting from one axis to another. The authors describe a highly automated, computer controlled system but can't find the commander and his staff. For example, once targets are designated by the airborne command posts:

> the identified targets are selected for engagement, the computer automatically selectes the weapon **according to the missions assigned by the commander**, delivers the target designation and generates the current guidance parameters.

This statement shows how the Soviet analysis of a Western command and control system is going to arrange the problem according to a force control model where the commander's mission is the central focus of the system.

The reconnaissance-strike system heralds the beginning of a change in the form of combat operations. The authors say that combat operations will change: the strike becoming more important because sudden surprise attacks and precision guided munitions will cause irreplaceable losses in a very short time. American and NATO reconnaissance-strike weapons include nuclear and conventional weapons both in offensive and defensive operations and battles.[14]

Reconnaissance-strike systems are "compressing" the time of all processes in combat operations to practically instantaneous data processing. The key time element in force control now becomes the weapon flight time to maximum target range.[15] What the authors call the steps of the data processing problem is really the familiar staff process of planning the operation:

- Detect and discover the enemy.
- Evaluate the data received.
- Generate decisions.
- Formulate missions.
- Position forces.

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[14]The choice of these terms, **operations and battles**, keeps this naval discussion at a force or theater level instead of on the higher level of strategic action.

[15]Hence Mach 3 missiles.

The reconnaissance-strike system is causing a change in the level of command controlling the strike. In the U.S. method, the organization and planning of attack was the province of the tactical grouping commander. Now, the "Americans feel" the command and headquarters of the operational level of the control system should organize and plan the attack since only at that level is the information from "hundreds of thousands of square miles" collected and analyzed.

The authors spend little time on how to counter the reconnaissance-strike system. They do prescribe locating the system elements with radio direction finding or optical and thermal field sensors, localizing its direction of use, and camouflaging own forces using decoys and false targets.

Lastly, the authors call the reconnaissance-strike system a first-strike system because it ensures the extremely accurate delivery of conventional weapons. The effectiveness of an attack is so high that a first-strike is feasible.

E. TRAINING STAFFS FOR COMBAT

Rear Admiral V. Lebed'ko addresses the "battle readiness of the control system" in his 1984 *Morskoy Sbornik article "Some Ways of Increasing the Combat* Readiness of Control Elements". He discusses ways to improve the training of "the control entity". This entity is the commander's staff. The first part of this section will outline in more detail the position of staffs in the control system of the Soviet Navy. Then, we will return to Rear Admiral Lebed'ko's article.

Hines and Petersen (1986) show that Soviet staffs appear at all levels of military action: strategic, operational, and tactical. "Force-level staffs", in the naval terminology of the Soviets, plan operational and tactical missions of combined arms. The next level up would contain front-level staffs planning combined arms actions over the front.

Staffs can also be organized for political-military purposes during peacetime diplomatic port visits as Peterson showed in Dismukes and McConnell (1979, p.99). These "cruise staffs" control the port visits of ships to foreign ports. They are responsible for preparing and conducting the port visit. The "cruise staffs" authority exceeds that of the detachment commander.

Of course, Lebed'ko is not concerned with cruises and port visits.Instead he outlines general principles to apply in training staffs to increase their combat readiness.

Defining his terms, Lebed'ko notes that the battle readiness of the control system is an important component of naval force readiness. This control system consists of

"control stations, staffs, and communications, automation, and situation coverage equipment". The battle readiness of the control system is defined by its capability to:

- Deploy at the designated time.
- Begin performing tactical functions.
- Successfully accomplish assigned combat missions under all conditions.

Time for deployment is the "chief element" to analyze. The staff's deadline for readiness has to be less than the time prescribed to ready forces under its control. The factors controlling this time difference are:

- The personnel's political and moral level
- Military discipline.
- Manning of authorized postions
- The operator's preparedness to perform their jobs at "control stations".
- "The readiness of the set of combat documents and equipment".

The staff officer's moral qualities are a strong sense of duty and "ideological conditioning"-the degree of political awareness and agitation they exhibit. In turn, ideological conditioning produces psychological stability under stress, a readiness to implicitly execute orders, and "persistence in carrying out command decision".

As an example of how one fleet directorate prepares staff officers for their work, Lebed'ko repeats the pledges they make. Each officer pledges to fulfill five of these items: 1) Master Marxist-Leninist methodology as the basis for quality fulfillment of any task. 2) Develop measures to assure continuity, reliability, and efficiency of force control. 3) Introduce automated means of control. 4) Prepare control stations for functioning. 5) Develop "forms and methods" to "increase supervision over the state of force battle readiness" and reduce the time required for supervision. 6) Improve "knowledge of the probable enemy's forces and weapons". 7) Analyze and collect data "about the situation in the fleet". 8) Study the combat experience of the Great Patriotic War and World War II, and others. These pledges become public property for the fulfillment of socialist competition in the "entire collective". The party's influence through the officers of the various political directorates or the influence of the party in every officer's daily life, according to Lebed'ko, causes them to strive for success in socialist competition.[16]

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[16]That statement of the party's influence on naval officer's daily lives is believable given the fact that 90% of all naval officers are party members. *Understanding Soviet Naval Developments*(1985, p.69).

Under the heading of training for staff officers there are certain especially important areas. All staff officers participate in tactical training problems. The purpose of these problems is to practice estimating the situation, preparing proposals for decision by the commander, and drawing up operational instructions, orders, and directives.

Operational training (command and staff exercises, games and planning sessions) "is the most advanced form of training" says Lebed'ko, and he then gives a succinct explanation of the staff officer's function: the staff officer's job is to prepare proposals for the commander-in-chief's decision, to inform subordinates of the combat missions (by travelling to the next lower echelon sometimes, Hines and Petersen (1986)), and organizing coordination and comprehensive support of combat actions. In their (Soviet) words, the staff officer's job is to assist the commander in the functions of control.[17]

In conclusion, the author discusses area of uncertainty in the "problem of continuity and reliability of control". Reliability of control means insuring the survivability of the control system in the event of battle damage. Some of the factors he sees are:

- Improving and perfecting organizational structure.
- Perfecting the methods of staff work.
- Studying the flow and regulation of command information.
- Introducing broad scale automation.
- Developing communications and reconnaissance equipment.

In the final analysis the author emphasizes that time is the critical measure. Thinking about readiness in terms of ability to perform a mission immediately is foolish. There is a quantifiable time involved--it just has to be compressed as far as possible.

[17]These functions are planning, organizing, regulating, monitoring, and reporting on the preparation of troops for combat. Ivanov (1977,pp.24-41).

VI. DISCUSSION.

A. IMPLICATIONS FOR THE U.S NAVY

We Americans tend to ignore the coherence of the Soviet system because American society is not coherent. Even the U.S. Navy's long standing rivalries between air, surface, and submarine communities contribute to the incoherence. Soviet hardware analysis often mirrors our own because the hardware analyst is removed from the socio-political context of the Soviet Military. We may understand and thoroughly analyze the range, endurance, and power densities of individual ships but have ignored the organization the ship works for. Conversely, the American strategic analyst often uses geo-political models of Naval strategy ignoring the combined-arms approach of Soviet Military Doctrine and thus missing the significance of the units in an exercise or crisis. The only way to really understand the Soviet Navy is to first understand their frame of reference. We need to use their definitions, their concepts, their version of reality to be sure we can explain their actions in their terms. Then we can apply American values, strategy, and tactics to overcome an adversary we have truly come to know.

B. CONCLUSIONS

The articles in this collection suggest that Soviet Naval measures of effectiveness are well established in many areas of Soviet Naval Science. Certainly at the lower levels of the Naval organization, the authors have shown us definite criteria for measuring effectiveness of the individual, sub-unit, unit, and force. The picture is not complete, however, the subjects aren't coherent. But systems thinking unifies all of the writing.

The system may be implicit or explicit in one article, but taken together, they all discuss common elements of a system; decision-making, feedback, monitoring, and control.[18] For example, the officer's weekly planning form has a column labeled "Control". The Soviet officer controls his subordinates. The U.S. Naval officer manages his. The two men may achieve the same results (e.g., getting their ship painted), but the *weltanschauung* (in Russian, *mirovozzreniye*) saying people are

[18]Taylor (1983) provides more detail on Soviet military systems thinking as it relates to troop/force control, or in American parlance, command and control. Taylor clearly shows the conceptual difference between Soviet troop/force control and American command and control.

managed will use different methods than the one saying people are controlled. Thinking about controlling people allows the Soviet officer to place himself in the system of the ship. The goal of the ship is combat effectiveness. Managing people, on the other hand, conjures up the image of a team captain, all the individuals count. Working together towards a common goal is the key to success. But is their a single measure of successful team leadership ?

The rest of the articles in this sample contain the same elements from control theory. Even when the Soviets describe Western systems, they use their framework of systems theory to explain the Western system's objectives. The article detailing the "reconnaissance-strike systems", for instance, shows how Soviet systems thinking has packaged different pieces of hardware into a new synergistic creation. Borrowing the nomenclature from arms-control talks shows that the concept is widely accepted and reveals the pervasiveness of systems thinking.

This brief review restates the thesis; the Soviet systems perspective has surfaced in their Naval Science writings. They have defined the goals of their system and have worked hard at defining ways to measure how well those goals are attained. By the act of defining measures of effectiveness, the Soviets display their ideas of Naval ship utility.

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